Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JUNE, 1914.

SOME FURTHER EXPERIMENTS WITH LIQUID DROPS AND GLOBULES.

By CHAS. R. DARLING, A.R.C.Sc.I., F.I.C.

In the issues of "KNOWLEDGE" for February and April, 1913, the author described a number of new experiments with liquids approximating in density to water, with special reference to the formation of spheres, drops, and columns, and the movements of globules on the surface of water. The present article is intended to supplement those which have previously appeared, and will be devoted to a description of some further experiments with the same class of liquids.

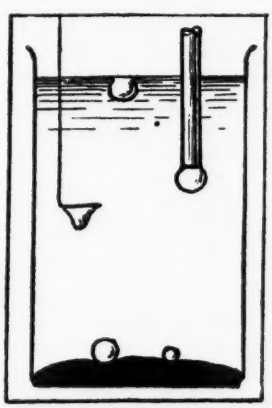

FIGURE 182.
Aniline skins enclosing water.

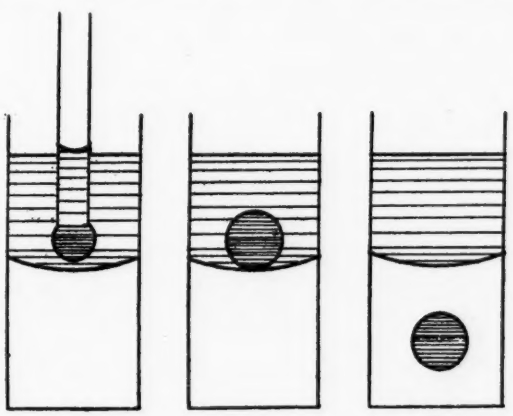

FIGURE 183. The "Diving" Drop.

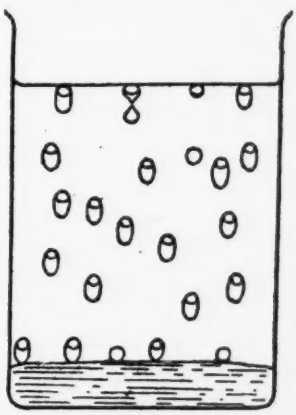

FIGURE 184.
The "Dancing" Drop.

WATER SPHERES IN ANILINE SKINS.

At first sight it might appear a difficult operation to enclose one liquid in the skin of another; nothing, however, could be simpler. A layer of aniline is placed at the bottom of a beaker, and covered with water to a depth of about two inches. A glass tube, of bore about one-eighth of an inch, open at both ends, is then inserted in the water, and lowered until the end is submerged in the aniline. (As the tube is open, water will enter it on immersion, so as to stand at the same level as that in the beaker.) On lifting the tube out of the aniline a skin of this liquid adheres to the end; and on raising it further this skin is inflated by the water in the tube, which sinks so as to maintain the common level. In this manner the film of aniline is distended by water, just as a soap-film is blown into a bubble

with air. In removing the tube entirely from the water the composite spheres remain clinging to the surface, or may fall through the water to the bottom of the beaker (see Figure 182). If a ring of wire, about three-eighths of an inch in diameter, be dipped beneath the aniline and then withdrawn a flat film will adhere, which may be stretched into the familiar shape of a falling drop by lifting the wire suddenly. Many interesting experiments are possible with these films, which are obtained more readily after the aniline has been in contact with the water for some days.

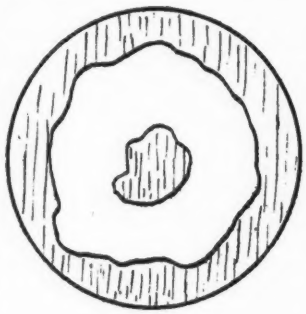

FIGURE 185.
The "Expanding" Globule.

THE "DIVING" DROP.

This experiment illustrates in a striking manner the force with which the surface of a liquid is restored to its normal shape after undergoing distortion. A quantity of dimethyl-aniline is poured on to water to a depth of three-quarters of an inch, and a sphere of the liquid, encased in a water skin, formed as described in the previous experiment (see Figure 183, A). On lifting the tube out of the liquid the sphere falls from the end, and rests on the joining-surface (see Figure 183, B), where it remains for a few seconds, when it suddenly bursts through the interface, and is projected with some violence downwards (see Figure 183, C), the skin of water having now disappeared. The drop—now composed entirely of dimethyl-aniline—then rises to the top of the water, breaks through the surface, and merges into the liquid above.

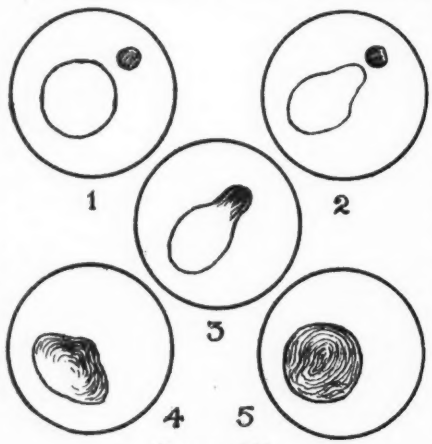

FIGURE 186.
The "Devouring" Globule.

This curious behaviour on the part of the compound sphere admits of a simple explanation. After resting for a time on the interface the under-part of its skin becomes continuous with the water below, with the result that the shape of the surface joining the two liquids is changed, the sides being now connected to the water-skin forming the upper part of the drop. This is an unstable shape for a stretched surface, which always tends to occupy the minimum area; and hence the skin assumes its normal shape, and with sufficient force to cause the drop beneath it to dive into the water to some depth, although dimethyl-aniline is lighter than water, and tends to float. On the sphere rising and breaking through the interface a similar action, in the reverse direction, takes place, but cannot be seen owing to the sphere losing its identity on entering its own liquid.

"Living" drops can be obtained by using ordinary paraffin oil instead of dimethyl-aniline; the effect, however, is not so well marked.

THE "DANCING" DROPS.

When a volatile liquid is heated beneath a layer of water the bubbles of vapour, on leaving the joining-surface and entering the water, tend to carry with them a portion of the liquid below. This may be seen on heating a layer of chloroform, about half an inch deep, covered by water to a depth of about three inches. The action, however, is much more striking if *monobrom-benzene* be used, as this liquid possesses a higher boiling-point than chloroform. On heating the liquid the vapour bubbles enter the water loaded with a drop of liquid, the amount detached being such as to make the density of the combined vapour and liquid drops about equal to that of water. On rising the drops enter a colder layer of water, which causes the vapour to contract and partially condense, with the result that the drops sink. On reaching the warmer region below, however, the lifting power is restored, and the drops rise again. The appearance of the drops is shown in Figure 184, but the chief interest of the experiment lies in the novelty of the movements. Some reach the surface at once, and there discharge the vapour, when the attached liquid falls; others dance up and down with great rapidity; whilst others, the densities of which are nicely balanced with that of the water, move slowly upwards or downwards. This simple experiment is at once interesting and instructive, and is one in which actual observation conveys far more than a mere description.

THE "EXPANDING" GLOBULE.

A globule at rest on the surface of water is maintained in equilibrium by the operation of three tensions, viz., water-air, liquid-air, and water-liquid, or interfacial. Any alteration in these tensions will disturb the equilibrium and cause the globule to alter in shape. This is shown in a striking manner by floating a globule of aniline on water and dropping into it a small quantity of quinoline, when the globule will be observed to expand violently in all directions, leaving a hole in the centre (see Figure 185). This action is even more intense if a drop of quinoline be placed on a globule of light lubricating oil, when it will be observed that the quinoline sinks through the globule,

without causing any disturbance, until it breaks through the junction of the oil and water, when the globule spreads out with such force as to be broken into several portions. This phenomenon is therefore due to an alteration in the interfacial tension, which now offers less opposition to the pull of the water-air tension on the globule, and hence spreading occurs.

THE "DEVOURING" GLOBULE.

When globules of different liquids are floating on the same water surface a tendency to join together is sometimes noticed, and the same applies to separate globules of the same liquid. This tendency to coalesce with other globules is shown in a marked degree by dimethyl-aniline, and may be utilised so as to give the novel appearance of one globule feeding on another. To show this effect to best advantage a small quantity of orthotoluidine is poured on to a clean water surface, when it breaks up into a number of active globules. A large globule of dimethyl-aniline is then formed on the surface, which at once proceeds to feast upon the orthotoluidine. The procedure is shown in Figure 186, which represents (1) the initial stage; (2) the large globule of dimethyl-aniline sending out a protuberance in the direction of the small one; (3) the small globule incorporated; (4) the protuberance withdrawn, causing a recoil which spreads the large globule laterally; and (5) the globule restored to its proper shape, showing streaks due to the orthotoluidine not being perfectly mixed—an operation which takes a short time, after which the globule becomes clear again. The process is then repeated, one after another of the orthotoluidine globules being absorbed until the surface has been cleared, when the "devourer" comes to rest in the centre of the surface. It is amusing to observe how the small globules sometimes retreat, as if trying to avoid capture, only to be pursued and made to share the common fate. The movements may be seen to better advantage when the surface is magnified by lantern projection, and resemble in a striking manner certain processes associated with life—such, for example, as a white blood-corpuscle (phagocyte) feeding on microbes. And it is interesting to note in this connection that some of the other movements of globules described by the author in previous issues of "KNOWLEDGE" show analogies to the movements of the lower organisms; for example, the pulsation of aniline globules and the motion of translation and subdivision of orthotoluidine; all of which only proves, however, that certain phenomena, usually supposed to be inseparable from life, may be produced with inert substances.

CORRESPONDENCE.

SINGLE TIDES.

To the Editors of "KNOWLEDGE."

SIRS,—Your correspondent, Mr. R. Shepherd ("KNOWLEDGE," Volume XXXVII, April, 1914, page 153), has unfortunately mistaken the locality referred to. It was not Southampton Water that was intended, but Freemantle, in Western Australia, where there is, as stated, but one tide a day. The information given by your correspondent, Mr. A. Stevens, of the Geographical Department, University of Glasgow, is very valuable, and to some extent serves to indicate the astro-geographical causes of the irregularity. If, however, we concede the main cause to be due to the Moon's declination—a factor that is certainly employed in the construction of the Freemantle Tables—we yet have to account for the partiality of this disturbance, inasmuch as the local geographical conditions at Aden and Freemantle (both cited by your correspondent) do not conform with those at Southampton Water, where there are two tides at the syzygies. Similarly, we have to ascertain the causes of the peculiar disturbance of the tides at Aden and Freemantle, on the theory that the Moon's declination is involved. If the astronomical factor $\frac{\text{R.A.}\,(\text{M}-\text{S})}{2}$ be allowed, then it appears it should hold universally, and such, doubtless would be the case but for local conditions, such as strong river flows into estuaries, and possibly, also, strong ocean currents. I suggest the latter as applicable to the cases of irregularity cited, and should be glad if any of your correspondents could confirm or correct this view.

W. GORNOLD.

SOUTH KENSINGTON, S.W.

RUSSIAN PEASANTS' ARITHMETIC.

To the Editors of "KNOWLEDGE."

SIRS,—On my way home from India in April a gentleman gave me the following method used by the Russian peasant when requiring the result of two numbers multiplied together without the help of multiplication. It seems so ingenious that I think it may be of public interest, and I shall be glad if you can find a place for it in "KNOWLEDGE." Perhaps one of your mathematical readers will explain how the thing is done. Say:

25×11	19×17	~~16 × 11~~
~~12 22~~	9 34	~~8 22~~
~~6 44~~	~~4 68~~	~~4 44~~
3 88	~~2 136~~	~~2 88~~
1 176	1 272	1 176
275	323	$16 \times 11 = 176.$
$25 \times 11 = 275.$	$19 \times 17 = 323.$	

The peasant halves the figures upon the left side, neglecting fractions, and doubles the right side to correspond; then he draws a pen through everything that is even on the left, right across, and adds the total.

The sum comes invariably right for any numbers.

(REV.) G. T. JOHNSTON.

TREDERWYN, THE DOWN,
BEXHILL-ON-SEA.

THE ZODIACAL LIGHT.

By THE REV. J. T. W. CLARIDGE, M.A., F.R.A.S.

WHAT a remarkable phenomenon is that luminous object in the heavens occasionally seen at this season of the year by the naked eye, and yet incapable of distinct observation by the telescope! Such is the Zodiacal Light. It may be taken for granted that of all the forms which light takes perhaps this can safely be described as the most delicately beautiful. More milky than the Milky Way, more translucent than the filmy nebulae, and not altogether unlike the Aurora Borealis, with which it has sometimes been associated, it seems like the concentrated essence of twilight, shooting up into the sky as the Sun goes down about the time of the vernal equinox, or preceding the Sun as it rises in the autumn. At sunset in March, April, or May, if the atmospheric conditions be favourable, there can be seen a bright tract of the heavens which may be defined as a kind of elongated triangular pyramid or spire resting upon that part of the horizon beneath which the Sun has set. Away from all glare of gas light or electric light, it may be discerned without much difficulty. Of course, there must be no moonlight, nor even the brightness of Jupiter or Venus, to interfere with its view. With regard to its position, for all practical purposes we may say that its axis coincides with the plane of the Ecliptic or of the Sun's equator. This definition, though fairly correct for high latitudes, does not accurately represent it as seen in the tropical regions, where its light is often very conspicuous, and may be seen throughout the year. To an observer in England the cone of light leans somewhat to the left, and lies along the line of the Zodiac. Hence the origin of the name "Zodiacal Light," given by Cassini in 1683. In concord with other celestial objects, it sinks in the west by virtue of the Earth's rotation, thereby showing that its existence is external to the Earth's atmosphere. Pliny, who flourished in the first century of the Christian era, in his writings seems to allude to this phenomenon under the name of "*trabes lucis*" ("beams of light"), and the renowned Kepler (1571–1630) came to the conclusion that the Zodiacal Light was an atmosphere of the Sun. Later on Cassini, who died in 1712, after several years of observations at Nice, remarked that the northern edge of the light leaned more and more from its ecliptical axis during the months of March and April, when the solar equator was increasing its inclination to the Ecliptic, and consequently he concluded that it was a solar appendage. He further described it as having a lenticular shape; that its diameter in June was equal to that of the Sun, but much larger in March. In 1731 Mairan spoke of it as a solar reflection, having the form of a flattened spheroid. Humboldt, in his striking work "Cosmos," gives some very interesting notes on the subject, not the least being, in his opinion, that the ancients were unacquainted with it, notwithstanding the clearness of the eastern sky. From his own observations in South Africa, he describes the light as of a "blazing" character at one time, and as an "exquisitely delicate and ethereal object" at another. The remarkable meteoric shower of 1833 caused a goodly number of speculations as to the composition of the light. By many it was thought at the time that the display was due to the Earth passing through the material of the light. No less a personage than Biot took up this argument, and suggested that the Earth actually passed through the node of this material. About 1852, during Commodore Perry's expedition to Japan, a long series of observations of the light was made by the Rev. George Jones, who was Chaplain on the U.S.A. frigate, the "Mississippi." His work, published in 1856, contains a mass of interesting detail, and it appears that he came to the conclusion that the Zodiacal Light was a ring of matter encompassing the Earth, and not the Sun; since he argued that the changes resulting from the observer's change of position on the Earth, as well as the alteration in position caused by the Earth's rotation, seemed to him much greater than could be explained if the ring were not relatively near the Earth. But surely to this it may be replied that no ring surrounding the Earth can in any way satisfactorily explain the phenomenon of the Zodiacal Light. But, assuming it were so, it is quite evident that, at a distance so moderate that a traveller in the tropical regions could recognise the change of position of the light as he passed from the north to the south side of the Equator, it would be invisible from places in high latitudes. In 1864 M. Chacornac observed the light in Paris and Lyons, and said that it was of sufficient power to obliterate stars of the twelfth and thirteenth magnitudes, and covers with a yellowish-red veil the region of the sky on which it is projected. The theory which connects it more immediately with the Sun has stood the test of more recent observations. The faint, yet exquisite, lustre has so far proved amenable to optical tests that the spectrum has revealed its identity with the solar radiance. The light is sunlight, and only differs from the latter in its intensity. It is due to reflection, and, whatever may be the nature of the material

which thus reflects the solar light, we may at once dismiss the idea that the Zodiacal Light is a mere extension of the Sun's atmosphere. There are dynamical reasons which render this idea untenable; and consequently we are driven to the conclusion that the phenomenon is caused by the presence of a multitude of small bodies, moving in orbits of their own around the Sun. In furtherance of this subject two points must be carefully borne in mind. The first is that there are phenomena of the light which indicate some resemblance, remote or otherwise, between its structure and that of comets' tails; so that not only meteoric matter, but also cometic matter, is probably present. The second is that it is highly improbable that the greater portion of the matter forming the light travels in orbits of small eccentricity around the Sun. Knowing that the orbits of meteors extend far into space, sometimes beyond the orbits of Uranus and Neptune, we must suppose that the meteoric and cometic matter of its light would travel in paths similarly eccentric, so that it will at times be far beyond the bounds of its visible extent. According to this theory the light should vary very markedly in appearance from time to time, and this, as a matter of fact, is precisely what has been observed, and remained unexplained until the eccentric nature of meteoric orbits was fully recognised. At the present moment the little bodies composing the light are believed to be something of the nature of Saturn's rings, the light, naturally, feebly reflected from the Sun, which renders it so indistinctly visible. This we learn from the researches made by the polariscope and the spectroscope. When we speak of "little bodies" in a cosmical sense, we are naturally compelled to enlarge our ideas with reference to magnitude. Sir John Herschel remarks: "Compared with planets visible in our most powerful telescopes, rocks and stony masses of great size and weight would be but as the impalpable dust which a sunbeam renders visible as a sheet of light when streaming through a narrow chink into a dark chamber." So it is with the Zodiacal Light. The Sun goes down below the horizon, but the rays shoot up into the mass of solid particles which revolves around it, and illuminate their surfaces, the aggregate effect to an observer on the Earth being that of a diffused sunbeam, taking the form into which the particles are grouped. Now this word "particle" must also be accepted in a magnified degree. Of course, it may happen that some of the constituent bodies are really small, and certainly none can be very large, otherwise they would not have escaped the careful scrutiny of the powerful modern apparatus. We may believe, then, that the total mass must be almost nothing as compared to that of the Sun. Hence the central luminary can suffer no perturbation from the vicinity of these revolving bodies, though collisions may occur among them, operating in the course of ages to effect a subsidence of at least some portion into the body of the Sun, or perhaps into certain of the planets.

An unpractised observer frequently fails to notice the Zodiacal Light, when it is not difficult to perceive it, because the very gradual diminution of its brightness, both upwards and laterally, deprives it of any definite outlines. We have the testimony of Schmidt, Jones, and other observers in support of the statement that it gradually fades away towards its edges. Jones especially calls attention to the variations in its brightness from time to time. Others have found it invisible, or at least very faint on some evenings, and it has been thought to be generally brighter in some years than in others. It is recorded that on January 31st, 1883, there were perceptible variations in its brightness relatively to the Milky Way. A distinction could be made between an inner and an outward zodiacal cone, mentioned by Jones as "the stronger and diffuse light." This might have been owing to the varying transparencies of the atmosphere through which the light is seen, or to varying sensitiveness of the observer's eye. With reference to the variation of brightness in different years, the evidence is not very conclusive. If one may venture to draw any inference from the various reports as a whole, it may be said slightly to favour the hypothesis of a variation in its brightness, coincident with the variation in the quantity of solar spots and of auroral displays, but the support at the best is not very strong. Among the few occasions when the light has been brighter than usual may be mentioned the month of March, 1843. That time was rendered remarkable by the sudden appearance of the great comet which caused then such a sensation. It so happened that the Zodiacal Light was noticed as brighter than usual; that Mr. J. Glaisher, writing from the Cambridge Observatory, made the singular mistake of confounding the two objects, saying: "The brilliant train which has for the last few nights attracted so much attention is doubtless only caused by the unusual brightness of the Zodiacal Light." The error was evident to all those observers who had seen the Zodiacal Light towering upwards from the horizon, having the Pleiades near its vertex, while the comet came sweeping downwards on the left. It is described as a magnificent spectacle not to be forgotten by any who witnessed it. It would seem as if the comet's presence were accompanied by some peculiar translucence of the atmosphere which rendered the Zodiacal Light more conspicuous.

There are also two phenomena which we may briefly notice in connection with this subject. One is the "Gegenschein," or "Counter Glow," and the other is the "Zodiacal Band." The "Gegenschein" is a faint patch of light seen very nearly opposite to the Sun's place. Professor Barnard has studied it for many years, and is of the opinion that it undergoes similar changes to the Zodiacal Light. He describes it generally as

XUM

a large and elongated patch of light, but not visible in June and December, when it crosses the Milky Way. Not very much is known as to its structure.

The "Zodiacal Band" is simply a prolongation of the light of the "Gegenschein." On some occasions it has been seen to stretch across the sky at midnight from the "Gegenschein," and connecting the evening and morning Zodiacal Lights. It is about thirty or forty degrees in width, and is best seen where it passes between the Pleiades and Hyades. But both the "Gegenschein" and the "Band" are extremely delicate phenomena, and require not only a clear sky, but a clear sight to glimpse them.

It would be presumptuous to say that the phenomenon of the Zodiacal Light has been fully solved. Yet, notwithstanding the apparent faintness of its luminosity, the real amount of light must be considerable. It must not be forgotten that this luminous cone is reared in that part of the sky which is bathed in the strongest twilight. Could it be seen amid a darkened sky, instead of being almost in the arms of day, its brightness would make it so conspicuous as to attract universal attention, especially as it differs in form from every other celestial object. Unlike the sunbeams, as they shoot upwards among the clouds during a gorgeous sunset, the Zodiacal Light is broadest at the horizon, and becomes narrower as it approaches the zenith. In the same way it differs from the fan-like rays of the Aurora Borealis. One thing, among the many, the heavens seem to tell with greater evidence from year to year is that space is not so void and empty as it was once thought to be; and that structures comparatively minute, as well as the immensely large, are widely spread among the framework of the universe.

SOLAR DISTURBANCES DURING APRIL, 1914

By FRANK C. DENNETT.

EVERY day during Aprii it was possible to direct the telescope upon the Sun, and the month proved to be one of great interest. Only once—on the 15th—did the disc appear free from disturbance, and spots were visible on the remaining twenty-nine. At noon on April 1st the longitude of the central meridian was 123° 4′.

As No. 5 remained visible until April 12th, it reäppears on our present chart.

No. 6.—A little group of pores first seen on the 12th, a larger, followed at twenty thousand miles by two smaller ones. On the 13th the eastern pore was much the largest, the others being very insignificant, and on the 14th this pore, with a tiny companion, alone remained, but were not seen after.

No. 7.—On the 16th a solitary pore, seen double on the 17th, and by 18th a group of spots and pores forty-one thousand miles in length. It was usually seen after as two spotlets, with a few pores, varying in number and position, until the 25th, when the spots were almost lost among the faculae.

No. 8.—A little group of protean form, seen from the 19th until the 21st. Its length was thirty-five thousand miles, but its changes of four could only be shown by a series of diagrams. The components appeared increasing when last seen.

No. 9.—A group of pores when first seen on the 26th, three of which were a little larger than the rest. By the evening these three had become sensibly larger. Next day the leader had increased to sixteen thousand miles in diameter, and another seven thousand five hundred miles. On the 29th the great leader was twenty-two thousand miles across, with penumbral extensions making it quite twenty-six thousand miles, the group being over seventy thousand miles in length. A bright inrush of photospheric matter from the eastern side was noticeable on May 1st to 3rd, when last seen.

No. 8.—On the 27th an enormous faculic area, 20° from north to south, was seen coming round the north-eastern limb, evidently marking the place of No. 5. Amidst this a spot and some pores were visible on the next day, and which dwindled until last seen on the 3rd.

Faculae were seen on the 6th and 7th around longitude 126°, N. latitude 24°. On the 24th and 25th faculic areas showed around longitude 43°, N. latitude 22°, and longitude 108°, N. latitude 17°. Also near the north-eastern limb on the 9th, 19th, 22nd, and 27th. Also north-west on the 16th. Faculae were visible in the south polar region, April 18th and 20th, and south-east on each day from 19th to 23rd inclusive.

Our chart is constructed from the combined observations of Messrs. J. McHaig, A. A. Buss, E. E. Peacock, J. C. Simpson, and the writer.

DAY OF APRIL, 1914.

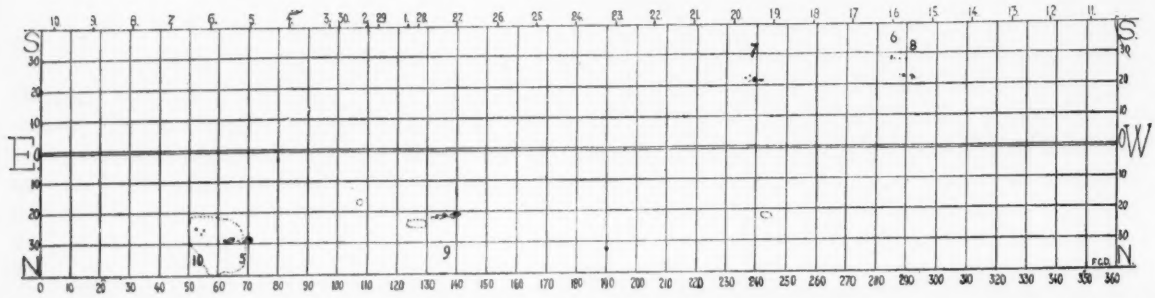

FIGURE 187. Taken February 13th, 1901. *Z* 84. Clear aperture of lens 0·9 in. Ratio 1:2. Focal length 1·8 in. Exposure 7h. 35m.—7h. 50m.=15 mins.

FIGURE 189. Taken March 9th, 1901. *Z* 114. Clear aperture of lens 0·9 in. Ratio 1:2. Focal length 1·8 in. Made by Alvan Clark, Cambridge Port, U.S.A.

FIGURE 188. Taken February 13th, 1901. *Z* 85. Clear aperture of lens 0·9 in. Ratio 1:2. Focal length 1·8 in. Made by Alvan Clark, Cambridge Port, U.S.A.

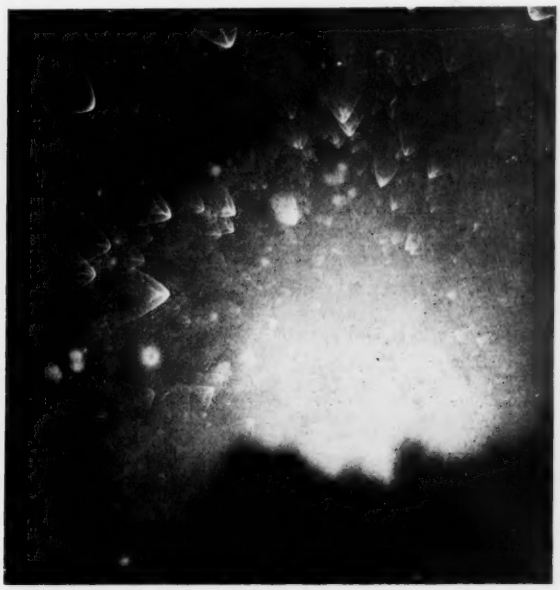

FIGURE 190. Taken March 19th, 1901. *Z* 144. Aperture of lens 0·9 in. Focal length 1·8 in. Exposure 7h. 52m. —8h. 0m.=8 mins.

From photographs by A. E. Douglas, Flagstaff, Arizona, U.S.A.

XUM

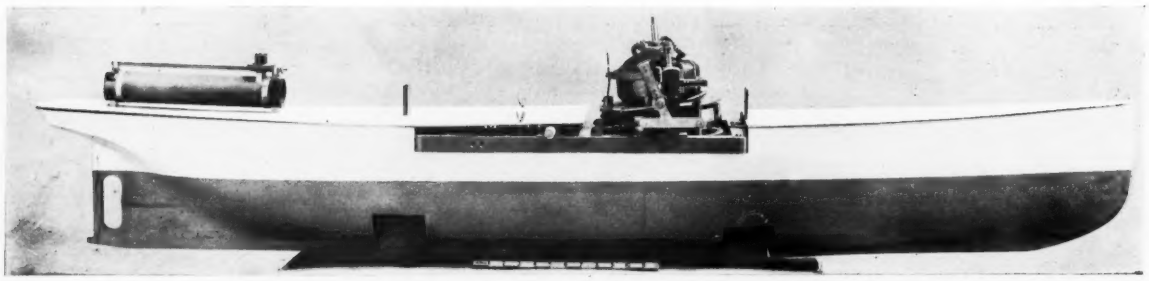

FIGURE 191. The Schilowsky Model Gyroscope Ship, showing the mechanism for stabilisation exposed to view.

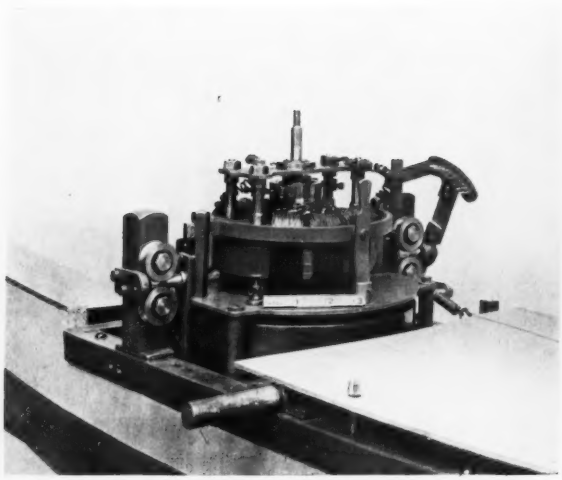

FIGURE 192. The stabilising Gyroscopic Mechanism of the model ship.

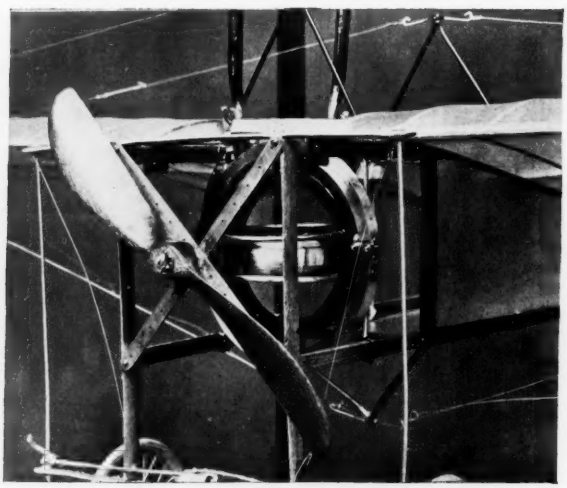

FIGURE 193. Enlarged view of the Gyroscopic Mechanism of the aëroplane.

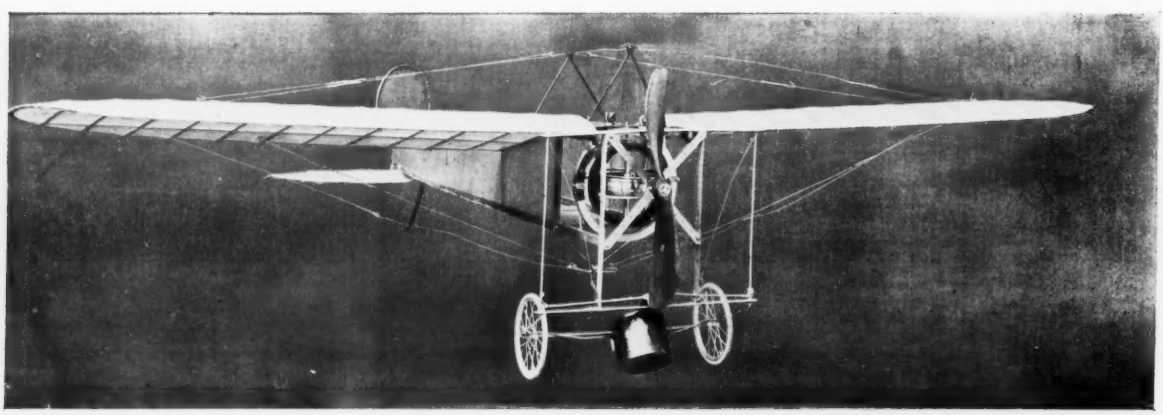

FIGURE 194. The Schilowsky Model Gyroscope as applied to an aëroplane. The model is suspended on pivots to allow it to oscillate freely in order to test the steadying effect of the gyroscope when in motion.

THE SCHILOWSKY GYROSCOPE APPLIED TO SHIPS AND AËROPLANES.

By J. HARRIS STONE, M.A., F.L.S., F.C.S.

In the April issue of this journal appeared an account of the mono-rail Schilowsky Gyroscope System as applied to trains and motor-cars—in other words, to earth-running vehicles—and it was there shown how important were the advances already made, and the practical applications which might be expected to flow from further developments of the marvellous invention. Our prognostication has proved to be neither incorrect nor too sanguine. The Russian scientific man has not been idle. During the last few weeks he has deposited in the South Kensington Science Museum, as presents to the nation, his first completed working models of the gyroscopic invention as applied to the stabilisation of ships and of aëroplanes. These two new models with the working mono-rail train already there, and which we described in the April issue, makes the South Kensington Science Museum the richest in practical gyroscope appliances in the world—the gyroscope as applied to the stabilisation of vehicles on earth, water, and in the air. The thanks of the nation are therefore due to M. Schilowsky for his generosity in thus enabling those interested in the subject to see for themselves, and to test the wonderful contrivances which will for ever be associated with his name.

The difficulties to be encountered in stabilising an earth-running vehicle on two wheels are, from a scientific point of view, greater than those to be overcome in an aquatic or aërial conveyance. A ship and also an aërial machine have already a certain amount of inherent stability, owing to the media in which they progress; and their line of support, of equilibrium, being above the centre of gravity, theoretically, it were easier to impart a still greater amount of stabilisation to such craft than to a motor-car or train. But, practically, the difficulties are still great, and it may be long yet before a ship is constructed which is rigid in all directions except that of direct progression, or an aëroplane made which will always rapidly and automatically right itself when upset by blasts of powerful winds or other causes. Now in a ship, if the movement (other, of course, than that of progression) were confined strictly to what is known as pitching—an upward and downward vibration only—sea-sickness and discomfort would, if not nearly obliterated, be rendered much less prevalent. It is when the pitching of a vessel is combined with the horrid rolling motion that the nausea reaches its zenith, and life to so many of us becomes almost unsupportable. The Schilowsky gyroscope, as applied to ships, is an attempt to minimise, reduce, or even to obliterate the rolling. As a ship afloat is a stable but an oscillatory body, the gyroscope is fitted in a stable manner.

As is shown clearly in Figure 191, the gyroscope is pivoted to the model ship by a system of sliding pivots affixed to it above its centre of gravity. If the ship is leaning to either side the gyroscope slides a little along its pivots to the inclined side (port or starboard, as the case may be), and at the same time a suitable arm engages a ratchet device, elastically pivoted to the frame, and this contrivance retards the swinging movement of the gyroscope. M. Schilowsky is the first practical experimenter with gyroscopes to demonstrate that in gyroscopes suspended above the centre of gravity, used for stabilising stable but oscillatory bodies, it is necessary to bring the troubled gyroscope and the vehicle to their normal positions, and that these results can only be effected by forces just opposite in action to those used for unstable bodies. In place of hurrying up the precision mechanism, a retarding precision device is employed which the inventor calls "anti-precessional." In the model ship at South Kensington it is clearly seen that since the retarding mechanism is put into operation in the vessel, to which an oscillatory motion is given, it restores the horizontal equilibrium of the vessel. Once restored, the gyroscope slides back, and disengagement occurs, leaving the gyroscope ready to repeat the equalising operation. It is in this device that the peculiar invention of M. Schilowsky is evident.

As in dealing with a ship, we have, as already mentioned, not to stabilise a very unsteady body, like a motor-car or a train: the gyroscope for a ship can be of comparatively trifling weight, and can revolve with comparative slowness. M. Schilowsky is of opinion, he tells me, that the weight of the ship gyroscope could be decreased to about one-half per cent. of the total weight of the ship; but I fancy it is extremely difficult, at the present stage of the science, to accept this as an infallible datum. I tried the ship model experimentally, and found that it rocked from side to side—port to starboard—just fourteen times before finding rest: that was when set into rocking motion with the gyroscope not in action. When the gyroscope was revolving, but without the side-ratchet contrivance being in gear, the vessel rocked just one half, or seven times. When the gyroscope was revolving, and the side-ratchet apparatus used for exercising the controlling influence on the instrument (in the model on the starboard side of the ship) brought into play the rocking movement was *at once* arrested. So

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quickly was this effected that it seemed little short of marvellous. It is as if some overruling, sentient power were dominant in the ship, which instantly, when rolling began, said, "No, you shall not roll!" This was apparent when the speed of the gyroscope was decreased to quite a trifling number of revolutions—only about five hundred a minute. With that speed the retarding device stabilised the model ship, though not with the same resistive strength as when it was running at two thousand revolutions.

From this description it will be apparent that there are attached to the gyroscope, as applied to ships, no heavy or large pendula as are used in the instruments for stabilising land vehicles, for the weight of the gyroscope itself takes the place of those heavy swinging adjuncts attached to the land instrument.

There is a very prevalent opinion that aëroplanes are very unstable—more so than any other vehicle—but this is hardly correct. In reality, an aëroplane is, like a bird, comparatively speaking, stable, but very oscillatory, and loses very easily its stability when a rolling motion is accelerated. It is therefore most important for the safety of those travelling aërially that the rolling motion should be stayed, and an attempt to attain this object is made by the Schilowsky gyroscope. Were the rolling propensity obliterated, the brains and strenuous attention of the pilot in the aëroplane (which are now largely engaged in overcoming the oscillations of his machine) could be directed solely to overcoming the longitudinal—the up-and-down—movements. In the aëroplane model (a beautiful and exact to scale monoplane of Blériot's) at the South Kensington Science Museum the weight of the pilot is represented by a heavy iron weight, and the gyroscope is proportionately not the weight of a single passenger. When the gyroscope was in action in the model I found it difficult to divert it from the horizontal position, even when pressing with some force on the extreme tip of a wing. Its stiffness was remarkable. The action of the gyroscope as applied to the aëroplane is similar to that used for vessels. Each rolling swings over the gyroscope, sliding on pivots, to the inclined side, and during this movement it comes into contact with the retarding spring, and, consequently, the anti-precessional mechanism is brought at once into play, with the result that the aëroplane is restored to its correct plane of flight. In full-sized aëroplanes the same petrol engine which drives the fan would also cause the gyroscope to revolve, and the alighting of such a fitted aëroplane on earth or water would therefore also be a matter of ease and great delicacy. Altogether, it is not unlikely that in the next few years we shall witness many marvellous, almost revolutionary, improvements in aëroplanes, especially as regards their safety and carrying capacity, some of which, at an rate, will be due to the use of the gyroscope—an instrument which has only just emerged from the status of a nursery toy.

It may be added that the two-wheel (mono-track) motor-car—figured and described in the April issue—fitted with M. Schilowsky's gyroscope, has been making many runs about London during the last week or two, to the great delight and wonderment of the public.

EARTHQUAKES IN NORTH AMERICA.

THE Rev. Father Tondorf, S.J., Director of the Georgetown Seismic Observatory, has contributed the following interesting note to *The Georgetown College Journal*.*

"The series of lesser shocks, recently experienced over that area of North America resting upon rock of the Laurentian period, has emphasized the fact that this region is by no means immune from appreciable seismic disturbances. Of timely interest, therefore, in this connection may be found the following account of a far more violent, wide-reaching and long-lasting disturbance of the same region, recorded in the year 1663 by the Jesuit missionary, Père Charles Simon. His original account in French was rendered into Latin by his friend, Père François Ragueneau. It is from this Latin version, which is in our archives, that the account is taken. Many incidental and picturesque details not of scientific value have been omitted, nor has any attempt been made to alter in any way the quaint phraseology of the eye-witness of this direful cataclysm."

The first part of the above-mentioned account we reprint below.

"February the 5th, 1663, chronicled as the day of the earthquake, broke tranquilly with sky serene. At five o'clock in the evening a sound was heard seemingly centred at a distance. A frightful crash followed, appearing to come from the lowest depths and the extreme confines of the earth, resembling in sound the battle of the waves and the roar of the sea. Thereupon followed a shower of stones, which shattered the roofs of the houses and burst into barns, chambers and the most hidden nooks. Finally the dust rose in whirling columns and formed into clouds. Doors suddenly opened and closed themselves; church bells rang out in token of the general alarm; steeples of churches, like tall trees, became the sport of winds, swayed in every direction; walls were broken, stones dislodged and timbers gave way; men rushed out of their houses while others sought refuge in houses. Thunder reverberated and lightning flashed in the heavens. The earth rolled to and fro under foot as a boat is restlessly buffeted about by the waves. The violence of the first shock subsided after about half an hour. Towards nine o'clock in the evening the earth again began to shake, and that alternation of shocks lasted until the ninth of September. During this period there was a great variety of dissimilar shocks. Some were longer, others shorter; some were frequent but moderate; others, after a long intermission, were more violent. These occurrences seemed to be more frequent by night than by day. Here and there, wide gaps appeared in the earth and frequent fissures. New torrents swept their way and new springs of very limpid water gushed forth in full streams. On level ground, new hills have arisen; mountains, on the other hand, have been depressed and flattened."

* March, 1914.

THE PHYSICAL CONDITIONS OF THE JEWISH RACE.

By ISRAEL COHEN, B.A.

THE Jew has many distinguishing characteristics both of an anthropological and a physiological nature. Their origin is to be sought partly in the racial stock to which he belongs, partly in the endless vicissitudes through which he has passed, partly in the environment in which he has dwelt, and partly in the mode of life that he has followed. His anthropological characteristics are due to the racial factor, and they owe their preservation in approximately their original condition to the social isolation in which he has for the most part lived since the days of his dispersion. His physiological characteristics are due in greatest measure to the hygienic laws which he has observed as part of his religion, and likewise to the sufferings which his people has endured in its struggle for existence, and the effects of which, both beneficial and detrimental, he has inherited as a national legacy. The characteristics of both kinds will be found in their fullest extent among the Jews who live in compact settlements, particularly in Eastern Europe, and in the Western communities composed of those who have themselves migrated from the East. The anthropological traits have a longer and stronger persistence than those of a purely physiological order: they are rooted in the blood, and will even reässert themselves in the grandchildren of those who have married outside the Jewish pale and withdrawn from the Jewish community. The peculiarities of a physiological nature are dependent upon more governable factors, and they become weaker or disappear in proportion as the individual Jew abandons the habits and customs of centuries and adopts the mode of life of his non-Jewish neighbours.

The distinctive features of the Jewish type consist of dark hair and eyes, and hence, owing to the preponderance of this feature, the Jews belong to the brunette group of the human race, or, more particularly, to the brunette group (Melanochroes) of the white race. The blond type, consisting of fair hair and blue eyes, and the mixed type, consisting of fair hair with dark eyes or dark hair with light eyes, are also found in small and varying proportions in different countries. The prevalence of this blond type has been explained by some anthropologists as the result of intermixture with the native populations, but this view is contradicted by the presence of fair-haired Jews in the north of Africa and in Syria, which are not inhabited by blond peoples, as well as by the presence of blond types among the Samaritan Jews, who have scrupulously safeguarded their racial purity. The causes of these diverse types among Jews must not be sought in their kinship or supposed intermixture with alien races, but in the forces of nature that originally determined the genesis of these respective types among other groups of the human race. The differentiation of pigmentation, as Dr. Zollschan has shown,* is the effect of varied climatic and geographical conditions: it is a protective measure of Nature against the injurious chemical and calorific effects of the fierce rays of the sun. The other main characteristic of the Jewish type is short-headedness (brachycephaly), the cephalic index of the majority of Jews being estimated by Dr. Judt as ranging from 80 to 83·6.† There are, however, many representatives of the long-headed, or dolichocephalic, type, as in Arabia, Morocco, and Algeria. This diversity of head-form is advanced by Dr. Fishberg ‡ as his principal reason for disputing the racial purity of the Jews, as he maintains that changes in the form of the head can be produced only by racial intermixture. But Professor Franz Boas,§ who has taken measurements of thirty thousand immigrants and descendants in New York, has shown that the change of environment from Europe to America has a potent influence upon such racial traits as stature, head-form, and complexion. East European Jews with brachycephalic heads become long-headed, and also increase in stature and weight. A similar phenomenon may also be observed among the immigrants and their descendants in London. Moreover, Nyström ‖ has shown that the shape of

* Dr. Ignaz Zollschan, "Das Rassenproblem" (Vienna, third edition, 1912), page 123.

† "Jüdische Statistik" (Berlin, 1903), page 421.

‡ Dr. M. Fishberg, "The Jews: a Study of Race and Environment" (London, 1911).

§ "Changes in Bodily Form of Descendants of Immigrants" (Washington, 1910).

‖ Dr. Ignaz Zollschan, "Das Rassenproblem," page 90.

the skull can be differently influenced by the pose of the body involved by one's daily occupation and mode of life, and that the increased pressure of brain and blood caused by intense intellectual activity tends to produce brachycephaly. Thus changes of head-form afford no proof of racial intermixture. It had long been supposed that the hook-nose is also a salient, if not the most distinctive, feature of the Jewish type, but careful observation among the Jews of Russia and Galicia has shown that from sixty to eighty per cent. possess straight or "Greek" noses. The Jewish hook-nose thrives only in the comic papers. That which constitutes the peculiarity of the Jewish nose is, not its shape or profile, but, as Joseph Jacobs was the first to point out, "the accentuation and flexibility of the nostrils," a view with which Ripley agrees.*

The predominance of the brachycephalic type among the Jews has led to a revision of the traditional view as regards their Semitic origin, since the peoples of the so-called Semitic stock were dolichocephalic. Even Jewish writers who are in favour of Jewish nationalist aspirations, such as Dr. Zollschan and Dr. Judt, have discarded the conventional theory of the origin of their people. Dr. Zollschan has pointed out that it is absurd to speak of the Semitic race at all, as this term, like the collateral expression, "Aryan," simply applies to a family group of languages, but affords no indication of the racial kinship of those among whom they are spoken. According to Zollschan the Jews at the time of their entry upon the arena of history were the product of an amalgamation of the peoples of North Africa with those of South-western Asia, and they were particularly influenced by the Assyrian and Babylonian elements among the latter as regards their complexion. Judt, on the other hand, believes that the Hittites formed the physical nucleus of the Jews, who owe to them their distinctive physiognomical traits, whilst according to Professor von Luschan the three principal elements in the composition of the Jewish type were the Semites, the Aryan Amorites, and the Hittites. But although it is impossible to establish with exactitude the genesis of the Jewish type, since anthropological science still provides a field of heated conflict, it is sufficient to know that, according to unbiassed authorities, the racial amalgamation of which the Jews are the product took place some four thousand years ago, and that the Jewish type has been preserved intact to the present day.

The evidence of history strongly supports the view that the Jewish race did not suffer any appreciable influx of alien blood in Europe. The Jewish community in almost every town was both locally and socially segregated from the rest of the population. There was a widespread feeling of hostility between Jews and Gentiles throughout the Middle Ages, which afforded little encouragement to mixed marriages, and both Synagogue and Church strictly forbade such unions. Moreover, the Rabbis discouraged proselytism, and the records of conversion show that the Jewish community lost far more in deserters than it gained in proselytes. The only notable exception consisted of the Chazars, a people of Turkish origin, who formed an independent kingdom in the south of Russia from the seventh to the eleventh century, and whose ruling classes embraced Judaism in 620.† But the descendants of these Jewish converts were subsequently absorbed among the Karaites, who do not intermarry with orthodox Jews, and thus they cannot form an argument against the purity of the Jewish race. In any case the amount of the intermarriage with Jews is not known to have been great, and its physical effects must have been eliminated in the course of a few generations, as small admixtures from an alien stock leave no anthropological trace behind them. Mixed marriages, so far as has been ascertained, are less fertile than purely Jewish marriages, owing either to racial incongruity or to the characteristics of the social stratum in which they mostly take place, and all but a tenth of the offspring of such unions go over to Christianity.‡ It may therefore be safely concluded that the Jews are comparatively free from any strain of alien blood derived from the nations of Europe, whatever admixture they may have themselves contributed to these nations. Beyond the zone of the Western world, however, there are indeed three historic cases of alien intermixture with Jewish blood: the Jews of Abyssinia, known as Falashas, who claim descent from the retinue of Menelik, the son of King Solomon and the Queen of Sheba, and who present a negroid type; the Black Jews of India; and the small and dwindling colony of Chinese Jews at Kai-Fung-Foo. But these abnormal types are comparatively few in number, and, owing to their remoteness and isolation, they cannot be considered as affecting the purity of the general body of the Jewish race.

If we desire a concrete and impartial testimony that the Jewish type has not undergone any appreciable alteration in Europe during the last two thousand years, we shall find it in the imposing monuments that have been brought to light from the buried cities of Babylonia. The bas-reliefs of Hebrew prisoners taken by Shishak in 973 B.C.E., and of the inhabitants of Lachish, who submitted to Sennacherib in 701 B.C.E., present a striking

* Article "Nose" in "Jewish Encyclopaedia," IX.

† According to A. Harkavy, "Meassef Niddahim," I. Other authorities give 740 as the date of conversion.

‡ W. Z. Ripley, in "The Races of Europe" (New York, 1899), has published photographs showing the similarity between Jewish types of Russia, Caucasus, Arabia, Syria, Tunis, Bochara, and India.

resemblance to the predominant Jewish type of the present day. The preservation of this type from so remote a period is due primarily to racial evolution and successive centuries of in-breeding, but it is not less due to common national experiences, which have endowed it with specific qualities of a physical and moral order. Behind the walls of the Ghetto the Jewish type was carefully protected from the influence of its alien environment, and there it also received a special impress, the product of exile and oppression. The chronic outbreaks of massacre and banishment, the unceasing reign of petty despotism, economic misery, and nervous alarm, have wrought traces upon the organism of the Jew: they have bent and stunted his body, while they have sharpened his mind and brightened his eye; they have given him a narrow chest, feeble muscles, and pale complexion; they have stamped his visage with a look of pensive sadness, as though ever brooding on the wrongs of ages. But the frame that has endured and survived so much suffering is also endowed with a high degree of resistance.

In the remotest regions there may be found Jews of a similar type, as in Aden and Galicia, in Egypt and Persia, in Samarcand and Palestine; and yet we cannot assert that there is a single uniform type at the present day. A few hours' careful observation among the Jewish inhabitants of a Western city, or even a few moments' scrutiny among the delegates of a Zionist Congress, would soon reveal the existence of varied types. The cause of this variation is not far to seek: it consists in the influence of local environment, which forces upon the Jewish physiognomy some of the traits of the predominant type, a process favoured in Western countries by the increase of social intercourse with non-Jews as well as by the preference of the non-Jewish type for marriage both by Jew and Jewess. Thus it is that several eminent Jews of the last fifty years have had little similarity to the average racial type: Cesare Lombrose in Italy, Sir Julian Goldsmid in England, George Brandes in Denmark, Baron Maurice de Hirsch in France, have all shown a marked resemblance to the characteristic type of their native country, whilst Dr. Theodor Herzl, on the other hand, recalled the majestic presence of an Assyrian emperor. But although these types show a divergence from what is popularly called the Jewish type, there is no ground for denying the existence of the latter, as is done by some writers, since the majority of Jews present—to use a mathematical term—the highest common factor of physical and physiognomical characteristics distinguishing them from non-Jews. The truest statement of the position would be that there is a variety of Jewish types, each possessing an unmistakable Jewish factor, and yet presenting a certain resemblance to the predominant local types, which results from the unconscious mimicry of muscular movements. This difference has been characterised as a difference in the social types of Jewry, which helps us to read in the face of each Jew the land of his origin, whether he is a native of Russia, Germany, England, or America. That which is popularly known as the Jewish expression is found mostly among those who live in or originate from Eastern communities, and it has even been observed to develop at a later age in the case of some who have not had it in their youth, but on the whole it diminishes among those who have constant intercourse with non-Jews, and who live beyond the influence of a Jewish atmosphere.

The physiological characteristics of the Jew are not due to any organic peculiarities of a racial origin, but to social, historic, and economic causes. Having dwelt for nearly two thousand years in towns, and for the greater period in the most insalubrious and congested quarters, and having been compelled to endure all manner of persecution in his struggle for existence, he possesses a constitution that combines a poor muscular development with a highly developed nervous system. His average height in Eastern Europe is five feet three or four inches, whilst that of the Jewish immigrants in the United States is five foot five inches;* but the native Jews, both of New York and London, are taller than their foreign parents, and thus demonstrate how susceptible is the physique of the Jew to the influence of environment. The inferiority of the Eastern Jew in chest-development is still more striking. Among healthy and normally developed people the girth of the chest equals or even exceeds half the stature; but this proportion is far from common among the Jewish masses of Russia, who present a larger percentage of military recruits with deficient chest-measurement than any other subject people of the Tsar.

Investigations spread over twelve years (1886–1897) have shown that among every thousand Jewish conscripts there were 491 whose chest-measurement was less than half their height, while among a thousand Christian conscripts there were only 128.† Dr. Max Mandelstamm, of Kiev, who had exceptional facilities for studying the physical conditions of the Jews in the Russian Pale, cites without reservation the testimony of military physicians, that sixty per cent. of the Jewish recruits have a deficient chest-circumference.‡ The Russian military authorities have accordingly lowered the standard of their requirements for Jewish subjects.

Despite his pallid face and feeble frame, the Jew displays a remarkable strength in resisting disease. Cooped up in the poorest, the most crowded and

* "The Immigrant Jew in America" (New York, 1907), page 282. † "Jüdische Statistik," page 306.

‡ "Report of Physical Condition of the Jews" (Fourth Zionist Congress, London, 1900).

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insanitary districts of great cities, where the air is foul and the light is bad, he succeeds in living to a great and even venerable age. Denied the boon of invigorating his stock with the blood of a country-bred element—an advantage open to all other nations—he nevertheless succeeds in perpetuating his line to a fourth and fifth generation. The secret of his health and longevity lies wholly in his mode of life, which is prescribed and fashioned by law and custom. But some of his immunity from certain diseases may rightly be referred to heredity, for a stock that has survived the perils and persecutions of many ages must have inevitably become stiffened in the process. The most tangible grounds of the good health of the Jew, however, consist in the dietary and hygienic laws which he observes as faithfully as the Ten Commandments, in his notable sobriety, in the weekly Sabbath rest, and in the quietude and purity of his family life. The legislation of the Bible and the Talmud was directed to secure the physical as well as the spiritual welfare of mankind, and all the religious codes accepted by orthodox Jewry preserve and emphasise this principle. The prohibition of certain beasts, birds, and fish as unclean for food, the careful examination of animals after slaughter, to see that they are free from any disease of the lungs or pleura, and the draining of the blood from meat before cooking, combine to protect the body from elements that might be injurious, and diminish the liability to contract such maladies as bovine tuberculosis, trichiniasis, and typhoid fever. The cleanliness of the person is secured by a strict insistence upon the use of baths and ablutions as almost a religious duty. The hands and face must be washed in the morning before any food is touched; the hands must always be washed after relieving Nature and after touching any part of the body that is usually covered, and they must likewise be washed before every meal. The Jew, moreover, laves his hands again after the meal, before uttering grace. A bath is prescribed before Sabbaths and festivals, and the *Mikvah*, or ritual bath (which must contain at least one hundred and twenty gallons of water), must be visited by every woman at least once a month.* The ritual observance of these practices is slowly falling into desuetude in Western countries, but it is faithfully upheld in Eastern communities. The cleanliness of the home is secured by the scrubbing and cleaning of the living-rooms on the eve of every Sabbath and festival, and by the thorough scouring and scraping of every nook and cranny in the house—walls, woodwork, floors, furniture—on the eve of Passover, the latter process being more thorough, if anything, than the usual English spring-cleaning.

The salutary effect of these dietary and hygienic regulations is supplemented by moderation in alcoholic indulgence; for although the Jew drinks wine for the ceremonial of sanctification on Sabbaths and feasts, and takes spirits on all festive occasions, he knows how to set a discreet limit to his appetite. There are no Temperance leagues in Jewry, and yet in no other community is the number of drunkards, or of those suffering from alcoholic excess, so small in proportion. The perfect repose, both of body and mind, secured by the Sabbath and by the more important festivals, which amount to thirteen days in the year, affords an excellent means of recuperation from toil and worry, for these religious celebrations are free from those drinking bouts which desecrate what should be the solemn days of other communities. And a further series of important factors consist in the early age of marriage, the sanctity of the family tie, and the devotion which parents lavish upon the upbringing of children. Finally, the whole philosophy of the Jew is coloured by the view that life is a very precious thing, and that everything may be sacrificed to its preservation. The guiding principle of the Rabbis, based upon the dictum of the Pentateuch (Lev. xviii, 5), was that the laws and statutes of the Bible were given so that man might live by them and not die through them.† Hence they declared that in case of danger to life one might commit any transgression except idolatry, murder, and adultery;‡ and the relaxation they allowed had special application to the Sabbath, on which the doctor might heal the sick, though all other work was forbidden.

In the light of this hygienic dispensation it is not surprising that the Jews everywhere have a lower rate of mortality than the people among whom they live, even though they generally dwell in the most crowded and insanitary districts. In no country that has been investigated does their annual mortality exceed 20 per 1000. Between 1876 and 1910 their mortality in Prussia, Bavaria, and the Grand Duchy of Hesse declined from 17·8 to 13·8 per 1000, and in 1911 their mortality in Prussia was 14·1, whilst that of the Christian population was 17·4.§ In Hungary their death-rate in 1911 was 15·3, as compared with 25·1 per 1000 of the general population;‖ and in Vienna, in 1908, it was only 12·4, contrasting with a mortality of 18·1 per 1000 of the general population.¶ They enjoy the same

* In Germany, of one thousand four hundred Jewish communities, seven hundred and seventy-two have a *Mikvah*. In Russia there is hardly a single community without one ("Zeitschrift für Demographie und Statistik der Juden," 1912, page 87).

† Talmud, *Yoma*, 85b. ‡ *Pesachim*, 25a.

§ "Zeitschrift für Demographie und Statistik der Juden," 1913, January and September.

‖ *Ibid.*, page 118. ¶ *Ibid.*, 1911, page 118.

advantage in Eastern Europe, too. Thus, in 1903, in Russia, they had a mortality of only 14·5, whilst that of the Orthodox Russians was 32·2, and that of the Mahommedans 24·3 per 1000; and in Poland they had a death-rate of 15·8, whilst that of the Catholics was 23·4.* Similarly, the average death-rate of the Jews in Bulgaria declined between 1891–95 and 1901–04 from 23·10 to 15·49 per 1000, whilst that of the general population only declined from 27·86 to 22·68;† and in Roumania the Jewish death-rate between 1907 and 1910 declined from 18·94 to 16·85, whilst that of the general population only declined from 26·4 to 25·38.‡ The same phenomenon has been corroborated among the Jews in London, Manchester, and New York. In Whitechapel, according to Dr. J. Loane, who gave evidence before the Royal Commission on Alien Immigration in 1902, the death-rate of the district, in the period 1880–1900, when the Jews settled there in large numbers, declined from 26 to 18 per 1000, and the foreigners have a death-rate of 15·6, as against the native rate of 20;§ in Manchester, during the years 1900–02, the death-rate for the entire city was 21·78, whilst in the Jewish district of Cheetham it was only 16·99;‖ and in New York, during the six years ended May 31st, 1890, the Jews had a mortality of only 14·85 per 1000, which was lower than that of any other race in the city.¶

The favourable position of the Jews in regard to mortality in general is exemplified very strikingly by the rate of infantile mortality, which everywhere forms a good proportion of the general mortality. Thus, according to the evidence given before the Royal Commission on Alien Immigration, the infant mortality increased in London in the period 1886–1900 from 153 to 161 per 1000 births, whilst the Whitechapel district showed a decline from 170 to 144; and in Manchester, in 1898–1901, the infant death-rate was lowest in Cheetham, the figures in 1899 being 104 for this Jewish district and 205 for the whole city.** Similarly, investigations have proved that those districts which are mostly inhabited by Jews in New York, Philadelphia, Chicago, and Boston, although the most overcrowded and insanitary, have the lowest rate of child mortality.†† In the Grand Duchy of Hesse the average rate of infant mortality in 1906–10 was 129 per 1000 of the Christian population, but among the Jews it was only 72;‡‡ and in Hungary, in 1910, the mortality of Jewish children under seven years of age formed 35·8 per cent. of all Jewish deaths, whilst among the Protestants it was 42·1, and among the Catholics 49·7 per cent.§§ Moreover, in Russia, according to the census of 1897, the infant mortality was 150 per 1000 births among the Jews, whilst it was 154·2 among the Catholics and 274·3 among the Greek Orthodox;‖‖ and in Cracow, which is typical of Galicia, the corresponding average rate for 1894–96 was 155 for the Jews, but 171 for the Christians.¶¶

The low death-rate of Jewish children is due to the scrupulous care of the mothers in rearing their offspring. Throughout Eastern Europe Jewesses, after marriage, very rarely work in factories or at home; they invariably nurse their children at the breast; and in all parts of the world they are known to display an excessive solicitude about the health of their children, and to seek the best medical advice upon the least suspicion that anything is wrong. The low rate of the general mortality must also be attributed partly, in addition to the factors previously mentioned, to the nature of the occupations in which Jews engage. The large majority, particularly in Eastern Europe, are merchants or small traders, or engage in indoor occupations, and thus belong to the long-lived class. Their avoidance of dangerous trades, such as mining, building, and railway employment, is due, not to any deliberate precaution, but, for the most part, to the fact that such occupations would involve, more seriously than others, regular isolation from the Jewish community and violation of the Sabbath. We are thus led to the conclusion that the low mortality of Jewry is due in the main to its specific social, hygienic, and economic conditions, a view that is supported by the fact that the death-rate of the Jews is smallest where they live apart, whilst it increases where they freely intermingle with their non-Jewish neighbours.*** But, apart from all these considerations, it is only natural that the Jews, who have waged such a long and stubborn fight against the forces of destiny, should have acquired a certain ingenuity in the art of defeating Death.

(To be continued.)

* "Zeitschrift für Demographie und Statistik der Juden," 1913, January and September, pages 39-44.

† *Ibid.*, page 17. ‡ *Ibid.*, 1912, page 16.

§ "Minutes of Evidence" (1903), 4538-4555. ‖ *Ibid.*, page 799.

¶ J. S. Billings, "Vital Statistics of the Jews in the United States" (1890).

** "Minutes of Evidence," 3960, 21742-46. †† "The Immigrant Jew in America."

‡‡ "Zeitschrift für Demographie und Statistik der Juden," 1913, page 7. §§ *Ibid.*, 1912, page 78.

‖‖ "Die sozialen Verhältnisse der Juden in Russland," page 29. ¶¶ "Die Juden in Oesterreich," page 33.

*** Among American Jews the death-rate of the native-born is 9·16 per cent., but that of the foreign-born 7·61 per cent. ("Jewish Encyclopaedia," Volume IX, article "Mortality").

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VARIABLE STARS.

By JOHN L. HAUGHTON, M.Sc.

Introduction.

Although the subject of stellar variability is one of extreme fascination, people who demand an answer to every why and wherefore connected with the subject that they are studying, will derive but little satisfaction from a review of our present knowledge of the causes underlying the strange phenomena detailed in this paper. At present most of it can be summed up in the words of Tennyson :—

> " A mystic star
> Between the less and greater glory varying to and fro,
> We know not wherefore."

And yet the knowledge that has been attained of the *modus operandi* of at least one class of variables encourages us to hope that some day all will be explicable.

The subject is so tremendous that it is impossible to do it justice in a short paper like the present one, while its very nature makes any account tend to degenerate at times into a rather too catalogue-like list of marvels. Nevertheless, the subject is of such interest and importance that the following brief summary should be of some value.

Classification.

Variable stars may be arranged into two classes : those which go through their light changes in a regular manner, and those whose period or range is irregular. For purposes of convenience, however, a much fuller system of classification was drawn up by Pickering ; slightly modified, it is as follows:—

(*a*) Temporary or new stars.
(*b*) Long-period variables (including stars with very irregular periods).
(*c*) Short-period variables.
1. Eclipsing stars (or Algol variables).
2. Non-eclipsing stars.
(i) Geminid variables.
(ii) δ Cepheid variables.
(iii) Cluster variables.

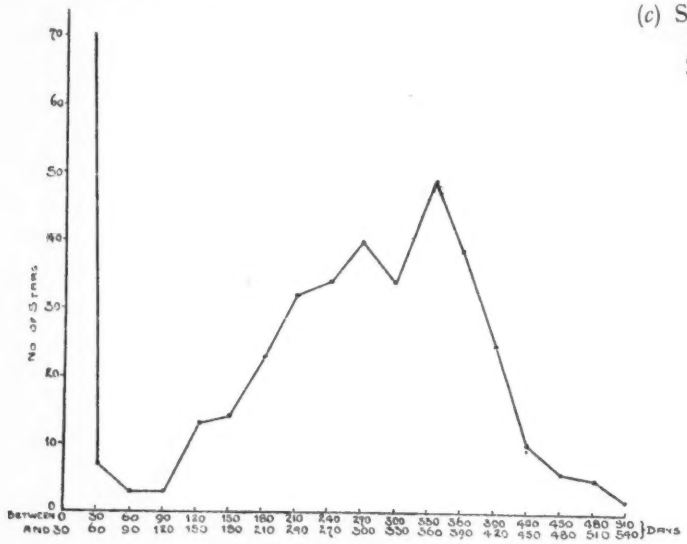

Figure 195. Distribution of Periods of Variable Stars.

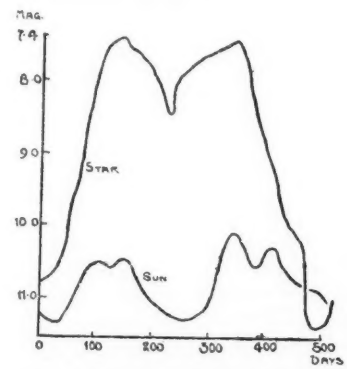

Figure 196. Light-curve of R Normae and curve of area of faculae on the Sun.

At first sight the distinction between " long " and " short " periods may appear to be an arbitrary one, but a glance at Figure 195 will show that there seems to be a real basis for this division. Of four hundred and fourteen variables fifty-two have periods of less than ten days, eight between thirty and sixty days, three between sixty and ninety days, while forty-nine vary between three hundred and thirty days and three hundred and sixty days. Thus stars with a period of over one hundred days may be reckoned as long- and those with less than this as short-period variables. Furthermore, it is found that the latter are, as a rule, brighter than the long-period variable stars, and tend to congregate in the Milky Way.

It will be noticed that this classification does not include temporary stars in the same group as long-period variables, for there is abundant evidence to show that they are in many ways quite different from these latter.

New Stars.

Between the years 134 B.C. and A.D. 1903 twenty-seven new stars have been observed, and several curious facts as to their distribution have come to light. In the first place, with only one exception,

they have appeared in the Milky Way, nine of them being in the adjoining constellations of Scorpio and Ophiuchus, an area covering about thirty or forty square degrees in the sky. Again, they seem to have come in batches separated by very long intervals. For example, three appeared in the seven years following A.D. 386, and for the next four and a half centuries none were observed.

A few facts concerning the most interesting of these remarkable objects will not be out of place here.

The most brilliant Nova of which we have a record of accurate observations was that which appeared in November, 1572, and was observed by Tycho Brahé. It was bright enough to be visible at midday to persons possessing good eyesight, and remained so for three weeks, after which it began to fade, and finally disappeared in March, 1574, that is, after sixteen months. Within one minute of arc of the position of this object as given by Tycho there is a small red star varying from the eleventh to the twelfth magnitude, and frequently appearing hazy and ill-defined in the telescope, and there appears to be no doubt that this is the once magnificent star of Tycho. *Sic transit gloria stellarum!*

A similar history was left by Kepler's star, which, in October, 1604, was brighter than Jupiter, and vanished seventeen months later. It, however, is not now visible in the telescope, or, rather, there is no star in the neighbourhood that can be certainly identified with it.

The Nova of 1866 is of special interest from two points of view. In the first place, it was the earliest temporary star which was examined spectroscopically; and, secondly, the very rapid increase in brightness was made manifest by one of those great strokes of luck that sometimes fall to astronomers. At 9 p.m. on the night of May 12th, 1866, Schmidt, of Athens, carefully surveyed the constellation of Corona Borealis, and noticed nothing unusual about it. He was certain that there was no star present as bright as the fifth magnitude, which was not there normally. Yet two and a half hours later John Birmingham, of Tuam, saw a second-magnitude star shining in that very constellation. Thus, in two and a half hours, a star rose from less than the fifth magnitude to the second, or, in other words, increased in brightness sixteen times. It is now a constant 9·5 magnitude star, and if we assume it to have been of this magnitude prior to the outburst, it must have increased in light-emitting power one thousand times.

Spectroscopically it was seen that T Coronae, as the star was called, gave a bright-line hydrogen spectrum superposed on a continuous one traversed by many dark flutings.

The spectrum changes of Nova Cygni, observed in 1876, were very remarkable. When first examined it yielded a solar spectrum with the Hydrogen, Helium, and Magnesium lines bright. The red C line of Hydrogen was the most prominent, but as the star faded, so did the C line, while a green one came to the front; later a blue one—suspected to be due to Nitrogen—took the lead. All this time the chief line in the green, which shows in the spectra of all gaseous nebulae, was becoming more and more visible until, by the time the object had dwindled down to the 10·5 magnitude, it was the only line which showed, and the star had assumed the appearance of a planetary nebula. Three years later it was of the twelfth magnitude, and the spectrum was stellar once more, and later still Professor Barnard, observing with the 40-inch Yerkes refractor, saw it as a 15·5 magnitude star having an ill-defined appearance.

Nova Aurigae and Nova Persei, both discovered by Dr. Anderson, showed all the spectral lines very much widened, and each bright line accompanied by a dark one. This has since been found to be the general characteristic of new stars. The spectrum of Nova Persei, when first observed, was continuous, probably due to its being discovered before the gaseous conflagration had become considerable. The dark lines were shifted by amounts appearing to indicate an approach of a thousand miles per second. Professor Newcomb has shown that the maximum speed that can be imparted to a star, due to the gravitative effect of the universe—certain assumptions as regard its size being made—is twenty-five miles per second; the maximum that has been observed in ordinary stars is two hundred and fifty-seven; so that this one thousand miles per second is a very abnormal speed, and seems to suggest that some force other than gravitation is at work in the case of this star.

To sum up, the following seems to be the normal course for a new star:—

It commences shining as an ordinary Helium star, which very soon displays a series of bright lines or bands, each one of which is accompanied by a dark companion of shorter wave-length. As the star fades these lines fade, and their place is taken by bands in the blue region, the object falling into the category of a Wolf-Rayet star. These bands in their turn give place to the characteristic spectrum of a gaseous nebula, which, after a greater or less length of time, is replaced by a continuous spectrum.

Each one of these phases, though lasting only for a few days or months in the temporary star, is to be found in an apparently fixed and stable condition in other stars.

LONG-PERIOD VARIABLES.

Long-period variables are distinguished from the rest by peculiarities other than the length of time taken to go through their cycle of changes. The range is almost always much greater and less regular than is the case with short-period stars, and while the latter are almost always Solar or Sirian in character, the former are invariably red stars.

The best-known long-period variable is *o* Ceti,

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or Mira, as it is called, because of its wonderful performances. When first noticed (in 1596) it was supposed to be a Nova. It has a period of three hundred and thirty-one days. At the brightest observed maximum (that of 1779) it was equal in lustre to Aldebaran, while the faintest minimum took place three years later, when it faded to the tenth magnitude. The average range is from the third to the ninth magnitude, *i.e.*, a change in brightness of 1 : 250, while the maximum observed difference —from the first to the tenth magnitude—is equivalent to a light range of 1 : 4000. Spectroscopic evidence shows that the maxima are due to conflagrations of Hydrogen, which occur with approximate regularity every three hundred and thirty-one days, the cause of these outbursts being unknown. As we have seen, the intensity of the action varies very considerably, and the period also is not rigidly obeyed. For example, the maximum in 1840 occurred a month later than it should have, and variations of fourteen days are quite common. The same year the fading was more rapid than the brightening; in every other observed period the reverse has been the case. The maximum generally lasts for fourteen days, but sometimes twice as long; also the shape of the light curves varies considerably. In 1898 the blue Hydrogen lines were tripled, as though a powerful magnetic field were present; but this has never been observed since. The dark lines of the spectrum show that Mira is receding with a velocity of sixty-six kilometres per second, while the bright lines give a much lower velocity. Truly, it is a well-named star.

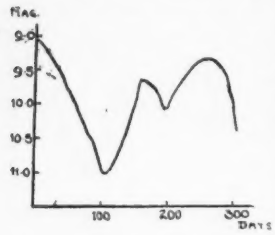

FIGURE 197. Light-curve of U Lupi.

R Normae is interesting as having a double minimum and a light-curve very much resembling that of the area of faculae on the Sun. Another point of resemblance between the two curves is that they are very irregular (see Figure 196).

U Lupi is another long-period variable, if, indeed, it has any period at all (see Figure 197). It seems to take a delight in falsifying predictions.

Remarkable as these antics are, they are completely thrown into the shade by the performances of η Carinae. This was first observed by Halley as a fourth-magnitude star in 1677. Père Noël rated it as second magnitude from 1685 to 1689, and Lacaille, in 1751, agreed with this. Burchell (1811–15) estimated it as of the fourth magnitude, and Fallows, seven years later, as second magnitude. In 1827 Burchell was astonished to see that it had risen to the first magnitude. Ten years later the star suddenly tripled its light and became equal to α Centauri. After this it faded, and then became brilliant once more, remaining almost as bright as Sirius for nine or ten years. Thirteen years later it was of the second, and the year following of the third magnitude, and in 1868 it became invisible to the naked eye. This, however, was not the end. It was followed with the telescope for sixteen years, during which time it continued to sink in brightness until, in 1886, its magnitude was 7·6. Since then it has remained at this point. What or when its next move will be, if indeed it makes any, is a matter of pure speculation (see Figure 198).

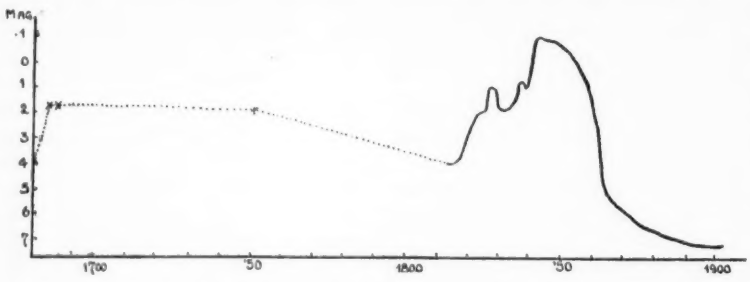

FIGURE 198. Light-curve of η Carinae.

It should be noticed that in all long-period stars, no matter how irregular they may be, the rise to maximum is gradual and spasmodic, and not sudden, as in the case of Novae.

Red stars are, as a general rule, variable. At Prague Observatory twenty-two of these bodies were taken under observation: two of them were periodical, six were irregular variables, and five vanished or lost most of their light. A small red star near Υ Cygni rose one magnitude between December, 1885, and January, 1886, and still keeps at the higher value. Chandler has pointed out that the redness of a variable star is, in general, a function of the length of the period of variation.

Reference may be made here to the well-known legend of the lost Pleiad. It is first mentioned, as then well known, by Aratus in a poem from which a quotation was made by St. Paul at Athens, and which had then been written about three hundred years. It is quite possible that in early times seven of the stars in the Pleiades were readily visible to the naked eye, and that one of them has lost a considerable portion of its light. Alcyone, the brightest star in the group, appears to be at present much brighter than in the days of Ptolemy or Al Sûfi. Professor Pickering

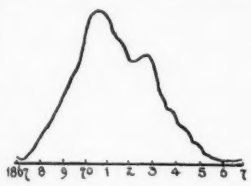

FIGURE 199. Curve of sunspot frequency (Ellis).

suggests that Pleione was the seventh or lost Pleiad. It is now just visible to keen eyesight on a clear night, and is twice as bright as Argelander estimated it to be fifty years ago.

. . . . . .

Many, and for the most part vain, are the theories that have been advanced to explain these irregular long-period variations. The only one to which we can refer at present is really a comparison rather than a theory. It is that the cause which makes sunspots increase and decrease is similar to the cause of long-period variations. The curve of sunspot frequency (see Figure 199) might well be taken for the light-curve of a typical long-period variable star. Furthermore, the development of bright lines in the stellar spectrum at maximum has its analogy in the development of flocculi and the increase in the corona of the Sun at times of sunspot maxima. At best, however, this is only one step in advance in the understanding of a very complicated subject.

(*To be continued.*)

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE STELLAR SYSTEM.—An interesting lecture on the Structure of the Star System was given by Professor Eddington at the April meeting of the British Astronomical Association. He gave a table showing the distance, size, velocity, and other details of the twenty nearest stars—those whose distance is less than a million times that of the Sun. He concluded that when the parallax surveys were more exhaustive about thirty stars would be found to be within this limiting sphere. Therefore the number within a sphere of four times this radius would be sixty-four times thirty, or, say, two thousand. This, then, is the number of stars that may ultimately be found to have an annual parallax of 0·″05, or greater. Smaller parallaxes than this have not at present much significance, since the uncertainty in the determination becomes practically as large as the parallax itself. Some of the stars in the smaller sphere (whose radius is five "parsecs," a "parsec" being a distance at which a star's parallax is 1″) are of the ninth magnitude. We may therefore expect that some of the stars in the twenty-parsec sphere are as faint as the twelfth magnitude. This is far fainter than the limit to which star parallaxes have at present been studied. But now that wholesale parallax determinations are being undertaken by photography it is only a matter of time before all the sensible parallaxes are detected. Professor Eddington pointed out that a noteworthy feature of our faint near neighbours was their abnormally high speed. From statistics of the star system as a whole he should have looked for a mean speed of twenty-nine kilometres per second among them, whereas he actually found sixty-eight kilometres. His explanation is that the stars which are intrinsically very small and faint have really a much higher speed than was previously suspected, but that these stars do not come into our catalogues of precision unless they are our very near neighbours, being otherwise too faint for meridian observations. Hence the study of our near neighbours has revealed a large class of intrinsically small, rapidly moving stars, of whose existence we should otherwise have remained in ignorance. This adds to the probability that on the whole the speed of stars varies inversely as the square root of their mass, a distribution which is known as "The Equipartition of Energy." Professor Eddington pointed out that this holds among the molecules of gases, but he expressed a doubt whether the condition of stars was really similar to this, in consequence of the much greater rarity of collisions. Mr. Maunder, however, reminds me that the late Mr. A. C. Ranyard anticipated a great many years ago—long before the correlation of speed and spectral type was detected—that the stars of small mass would have the highest speeds simply on account of the mutual gravitation of stars, and quite apart from any actual collisions. As they approached each other the star of smaller mass would move quicker (just as the Moon moves quicker than the Earth in their mutual monthly journey). Supposing that no actual collision occurred, most of this acquired speed would be lost again on recession, but a little would remain, and in the course of time a succession of such encounters might produce the speeds we actually find. There is at least one case of a large and massive star with a very high speed, viz., Arcturus, whose speed is estimated as two hundred and fifty miles per second. It is impossible at present to give any explanation of the manner in which this speed developed.

Professor Eddington passed on to deal with the "Giant and Dwarf Stars." Professor H. N. Russell was the first to point out that there was clear evidence that the stars of spectral type M (banded spectra) should be divided into two classes: The Giants, which are highly luminous, but at great distances; and the Dwarfs, which are our near neighbours, and whose intrinsic luminosity is very low. Since that time the evidence for these two classes has grown clearer, and a suggested explanation is that the M type marks both the beginning and the end of a star's career as a Sun. This view is elaborated in some detail by Professor Russell in the *Observatory* for April. Giant M stars on this view are very large and diffused, but their temperature has not yet reached its maximum. Their great bulk is the cause of their high luminosity. We may take Antares and Betelgeux as types. These giants are supposed to pass through types K and G, reaching type B if their mass is great enough (it has been deduced that B stars have about three times the mass of average stars, so that only stars of great mass attain this type). Then, as contraction proceeds, temperature passes its maximum and begins to decline. The spectral types are now passed through in the order BAFGKM; when the last stage is reached the star is near the end of its sunlike career, and its temperature has become low, and its atmosphere very absorbent. They are not necessarily all of small mass, though the dwarf M stars in our neighbourhood appear to be so. But if the stars all began their career at about the same time those of small mass would attain the M stage much sooner. Statistics show that, in space as a whole, the Giants are much rarer than the Dwarfs: this perhaps makes it likely that these giants are great in mass, not only in bulk, and therefore that each stage of their career is greatly prolonged. It is of interest to note that Sir J. Norman Lockyer suggested many years ago that the maximum temperature came in the middle of a star's career, and that among the lucid stars we could find examples both of increasing and diminishing temperature. He differed in the order in which he put the spectral types, but at that time there was much less information than is now available as regards correlation of distance, mass, absolute brightness, and spectral type.

The difficulty about Professor Russell's new hypothesis is the almost perfect agreement between the spectra of the giant and dwarf M stars, although their physical condition

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is supposed to be utterly different; however, it may be that the differences of spectral type depend almost entirely on temperature, and that the well-known M bands, due to titanium, and so on, are simply an indication that the temperature is too low to completely volatilise these substances.

Professor Russell points out that, in cases where a star separates into two nearly equal masses, tidal action will not increase the distance between them much beyond its initial value; so that double stars that are now widely separated must have begun their career at a similar distance. He explains the number of spectroscopic binaries among stars of the A type by supposing that these have separated after the parent mass has reached a considerable degree of compression, while the more widely separated binaries of solar type separated when the parent mass was still very large and diffused.

COMETS.—Kritzinger's Comet has been an easy telescopic object in April, and is likely to be somewhat brighter in June, as it does not reach perihelion till June 4th. The following table gives its positions at 11 p.m. on the days named :—

Date.	Right Ascension.	N. Decl.	Log. dist. from Sun.	Log. dist. from Earth.
	h. m. s.	° ′		
June 7	21 6 52	42 24	0·0779	9·7569
,, 11	21 22 6	43 24	0·0787	9·7679
,, 15	21 36 56	44 14	0·0801	9·7777
,, 19	21 51 12	44 56	0·0820	9·7862
,, 23	22 4 43	45 29	0·0845	9·7932

It will be due south at 4 a.m., but from its high north declination it will be observable throughout the night.

Delavan's Comet has become a morning star, but it will scarcely be observed before the middle of July, owing to its proximity to the Sun.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

CHEMICAL TEST OF PREGNANCY IN ANIMALS.—An ingenious method of recognising pregnancy in its earliest stages from the results of an examination of the blood of the animal has been devised by Dr. Abderhalten, and is described in outline in the *Bull. Agric. Intell. and Plant Diseases* (1913, XIV, 1745).

It is based upon the fact that an enzyme, possessing the property of breaking down the proteins of the placenta, develops in the blood of a pregnant animal, and disappears again about ten days after the birth of the young animal.

In testing for this enzyme, some of the blood serum of the animal is mixed with placenta-protein, derived from an animal of another species, and placed in a membrane which is suspended in water (containing toluene as a preservative) and incubated at 37° C. for sixteen hours.

The solution which has dialysed through the membrane is then tested with a hot one-per-cent. solution of ninhydrine (triketo-hydrindene hydrate) and if, after cooling, a deep blue colour is produced, the presence of the specific enzyme is indicated, and the animal is pregnant. In the absence of the products of this enzyme the dialysed solution will not react with ninhydrine, and it may be inferred that the animal is not pregnant.

A FIRE-DAMP WHISTLE.—The requirements of an indicator for fire-damp (methane) in a mine are that it shall be simple, sensitive to the gas, and readily handled by the miner. The Davy Safety Lamp fulfils these conditions, and shows the presence of fire-damp by the appearance of an aureole round the flame, the size and intensity of which increase with the proportion of methane. It has the drawback, however, that the flame may, under certain conditions, cause ignition of the gas outside the lamp, and several explosions have been traced to this cause.

To obviate the danger, Professor Haber has devised an indicator based on acoustical principles (*Journ. Soc. Chem. Ind.*, 1914, XXXIII, 54). Essentially, this consists of a brass cylinder containing two small pipes, which are tuned to give the same note in air, and these are blown with the same current of air from a hand-pump, which forms the outer sleeve of the cylinder. Membranes are interposed to prevent the current of air from entering the pipe tubes, or resonators, and the space beyond each pipe thus forms a closed gas chamber. The pitch of the note given by the pipe will therefore depend upon the nature of the gas contained in each chamber.

In the case of one pipe the chamber is filled with air from outside the mine, while the air from the mine is brought into the closed gas chamber of the other pipe, after being filtered through soda-lime to remove dust, moisture, and carbon dioxide.

If the air of the mine contain methane, the two pipes, when sounded by means of the hand-pump, will give beats, the frequency of which will increase with the proportion of the dangerous gas. When the amount of the fire-damp approaches the explosion limit the beating of the notes of the two pipes will produce a characteristic " trill," which will warn the miner to withdraw.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

NICKELIDE OF IRON.—In an investigation of the chemical and mechanical relations of iron, nickel, and carbon, Professor J. O. Arnold and Professor A. A. Read found that in alloys of nearly pure iron and nickel a critical mechanical point exists at about thirteen per cent. of nickel. This percentage corresponds with the formula Fe_7Ni, and it would appear, therefore, that there exists a definite alloy of iron and nickel of this composition. This alloy is remarkably tough, and has much the highest tensile strength of the whole series. A steel containing 13 per cent. of nickel and about 0·55 per cent. of carbon was sufficiently hard to defy machining, the hardness of the alloy itself being here augmented by a large quantity of dissolved nickel carbide.

BRONZE.—As bronze alloys are largely used at the temperatures of high-pressure steam, it is of the greatest importance to know how the strength of such alloys changes at these temperatures, and in a paper read before the Institute of Metals by Mr. John Dewrance, the results of tensile tests made at different temperatures are given. Gun-metal composed of copper (eighty-eight per cent.), tin (ten per cent.), zinc (two per cent.), was found to lose its strength rapidly with rising temperature, from 350° F. The addition of 0·5 per cent. of lead, however, caused the strength to be maintained up to 550° F. The author suggests that, as lead has this effect, it is probable that further investigation might prove that some other ingredient might preserve the strength of bronze at even a higher temperature.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

THE LATE EDUARD SUESS.—With the peaceful close of the life of Eduard Suess geography and geology lost perhaps their largest-minded and best-known student. Born in London in 1831, the eldest son of a German wool-merchant, Suess might have been claimed by the British School but for the fact that on the rise of the Australian wool industry the German waned, and his parents went to Prague. They became interested in a large business firm in Vienna, and their son at first entered the business.

His natural bent soon asserted itself, and at the age of nineteen he published some notes on the geology of Carlsbad and the mineral waters. In 1851 he entered the Imperial Museum of Vienna as an assistant, and spent the following ten years of his life in the study of the vast palæeontological collections of the museum. In 1857, with a reputation as a biologist and geologist already made, he became Professor of Geology in the University of Vienna.

He had already thought much on the problems of palaeogeography, and studied them widely. A rare gift was his of grasping details, and yet of seeing each in its true relation. From the most complex mass of detail he could pass securely and easily to general principles. In 1875 he had matured his views on evolutionary geography, and in that year published a small work, "Die Entstehung der Alpen." Ten years later the first volume of the epoch-marking "Antlitz der Erde" appeared. With its appearance the now well-known teaching of Suess obtained its recognition, and within twenty years the Oxford translation into English of Dr. H. Sollas, and the valuably annotated French edition of M. de Margerie, had begun to be published.

The contributions Suess thus made to science are too well known to be recapitulated here. They place his beside the names of Darwin and Lyell in the honourable roll of science. Of his activities in other spheres a word may be said. In 1862 the sanitation and water supply of the city of Vienna were in a most unsatisfactory condition. In that year he wrote an essay on water supply which attracted attention, and in the same year he found himself a member of the City Municipal Council. At his instigation a pure water supply was brought to Vienna from the Alps by means of an aqueduct one hundred and ten kilometres long, and the citizens testified to their appreciation of the work by conferring on Suess their highest honour. He subsequently spent thirty years in honourable and distinguished service in the Austrian Parliament.

Professor Judd has spoken elsewhere of the rare and kindly characters which marked Suess in his relations with his fellows. He seems to have recollected with pleasure his infant connection with this country, and the Royal Society of London, expressing their appreciation in concert with the learned societies of the globe, elected him a foreign member, and awarded him the Copley medal. He was also a Wollaston Medallist of the Geological Society.

AN ANGLO-SWEDISH ANTARCTIC EXPEDITION.—For many purposes the period during which exploring parties are in residence in polar regions, making continuous observations, is too short. From Sweden comes the suggestion that in 1915 an expedition should proceed to the part of the Antarctic Continent opposite South America, and continue its work there until 1920. A continuous series of observations covering five years would be invaluable for the elucidation of climatological and glaciological problems. Professors J. G. Anderson and O. Nordenskjöld are the initiators of the scheme. Sufficient money has been promised in Sweden for acquiring a vessel and erecting a commodious station at the main base. Of the annual cost of maintenance the Swedish Parliament is expected to provide half, and there is promise of the other half being raised in this country. Whaling companies, operating in the neighbourhood of South Georgia, are depended on for aid in transport of provisions and plant, and in maintaining communications with the outer world. The scientfic staff will consist of a geologist, two biologists, a cartographer, a meteorologist and geophysicist, and a surgeon. Two of these will be English.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

FURTHER DISCOVERIES AT PILTDOWN.—Very careful search of the gravel-pit at Piltdown, in which the famous skull of *Eoanthropus dawsoni* was found, has led to further discoveries, described in *The Quarterly Journal of the Geological Society*, April, 1914. The most important find is a human canine, which, according to Dr. Smith Woodward, almost certainly belongs to the skull of *Eoanthropus*. There were also found two human nasal bones, and a turbinal—the latter, however, in very bad condition. Additional mammalian remains found in 1913 were a fragment of a tooth of *Stegodon*, and an incisor of a beaver (*Castor fiber*).

Dr. Smith Woodward believes that the nasal bones resemble those of the existing Melanesian and African races, rather than those of the Eurasian type. The canine tooth, however, "is distinctly larger than any hitherto found in the genus *Homo*, and differs fundamentally in having completely interlocked with its opposing tooth, which worked downwards on its inner face as far as the edge of the gum." The permanent tooth of the extinct *Eoanthropus* is almost identical in shape with the temporary milk-tooth of present-day man, and it is concluded that the resemblance between *Eoanthropus* and man is greater than that between the former and any known ape.

The gravels at Piltdown have now been divided into four distinct beds. First, there is surface soil, one foot thick, containing subangular flints, flint-implements of all ages, and pottery. Below this comes a sandy loam, two feet six inches thick, with lenticular patches of dark ironstone gravel and subangular flints. In this bed one Palaeolithic worked flint was discovered. Then comes the bed, at the base of which *Eoanthropus* was found. This consists of a dark ferruginous gravel, with subangular flints and tabular ironstone, and containing, besides *Eoanthropus* remains, Pliocene rolled fossils, *Castor*, *Stegodon*, etc., "eoliths," and one worked flint. This bed is eighteen inches thick, and has a floor covered with depressions. Finally, there is a bed, eight inches thick, of yellow, finely divided clay and sand, believed to represent a mud reconstructed from the underlying strata (Tunbridge Wells Sand). Mr. Dawson believes that the fossiliferous bed is mainly composed of Pliocene drift, probably reconstructed in the Pleistocene epoch.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

PHENOLOGICAL OBSERVATIONS, 1913.—At the Meeting of the Royal Meteorological Society, on April 22nd, Mr. J. E. Clark and Mr. R. H. Hooker presented their Report on the Phenological Observations from December, 1912, to November, 1913. This dealt with the dates of flowering of plants, the song and migration of birds, the appearance of insects, and also the character of farm crops. The chief characteristics of the weather were an open winter, a wet spring, a summer very dry, but neither sunny nor warm, and a uniformly mild autumn. The mean dates of the flowering of the thirteen selected plants for the British Isles were :—

Hazel	Feb. 12	1 day early.
Coltsfoot	,, 22	14 days early
Wood-anemone	Mar. 25	5 ,, ,,
Blackthorn	April 4	7 ,, ,,
Hedge Mustard	,, 20	4 ,, ,,
Horse Chestnut	May 11	average
Hawthorn	,, 14	2 days early
White Ox-eye	,, 31	average
Dog Rose	June 6	5 days early
Black Knapweed	July 7	3 days late
Harebell	,, 11	1 day late
Greater Bindweed	,, 13	1 day early
Ivy	Sept. 29	average

With regard to birds the mean dates for the British Isles were :—

Thrush first heard	Jan. 18	5 days early
Swallow first seen	April 19	1 day late
Swallow last seen	Sept. 30	12 days early

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Cuckoo first heard	April 26	3 days late
Flycatcher first heard ...	May 17	2 days late

The mean dates of the first appearance of insects were :—

Honey Bee	Feb. 23	3 days early
Wasp	April 14	1 day late
Small White Butterfly ...	May 2	13 days late
Orange Tip Butterfly	,, 11	average
Meadow-brown Butterfly	June 19	5 days late

With regard to the crops, wheat was just under average ; barley in England was not much below average; oats, which require plenty of rain in the early summer, were very deficient in England, but satisfactory in the moister Scotland and Ireland. Potatoes were a heavy crop everywhere. Roots were deficient in England, especially in the drier Midlands ; in Scotland and Ireland roots were very good. Hops were a poor crop, and a special feature of the season was the unusual difficulty of estimating the yield until the hops were picked. The hay crop was abundant, and an interesting feature is that, in the South and Midlands, the hay from clovers and rotation grasses was, relatively. much better than that from permament meadow land. Harvesting began, in England, at about the average time—a shade earlier in the case of wheat, a little later in the case of oats. In Wales it was a little later. There was a tendency for the dates to be rather earlier on the eastern side of the country than in the west. The duration of the harvest was also about an average, and rather longer than usual in Wales ; in this case also it was distinctly shorter in the east than in the west. The explanation is that in the moister and somewhat later western west and north the broken weather set in in September, before operations were completed ; whereas in the south the corn had mostly been got in before the conditions became unfavourable. The quality of the crops was good in the case of wheat and barley, but that of oats was less satisfactory.

WHAT IS A MILLIBAR ?—In the April number of " KNOWLEDGE " reference was made to the fact that the U.S. Weather Bureau had adopted the C.G.S. units for the daily charts of the Northern Hemisphere, the issue of which began on January 1st, and that the Meteorological Office had also employed these units in the *Monthly Weather Reports*. From May 1st the Meteorological Office has introduced these units into the *Daily Weather Reports*. The barometer readings are consequently now given in millibars, and the isobaric lines are drawn for centibars. The amounts of rainfall are also given in millimetres instead of inches.

The absolute unit of pressure on the Centimetre-Gramme-Second system is the dyne per square centimetre. As this unit is exceedingly small a practical unit one million times as great has been suggested. This unit, the megadyne per square centimetre, is called a " bar." In the *Daily Weather Report* the centibar and the millibar, respectively the hundredth and the thousandth part of the " bar," are adopted as working units. The relation between the millibar and the inch of mercury is given in the following table :—

Millibars.	Mercury Inches.	Millibars.	Mercury Inches.
960	28·35	1010	29·83
965	28·50	1015	29·97
970	28·65	1020	30·12
975	28·79	1025	30·27
980	28·94	1030	30·42
985	29·09	1035	30·56
990	29·24	1040	30·71
995	29·38	1045	30·86
1000	29·53	1050	31·01
1005	29·68	1055	31·16

On the weather map in *The Times* newspaper the isobars are now given in centibars, with the equivalent English inches at the other end of the lines. If this method be continued, those who consult the weather maps will, in the course of time, get accustomed to the new values.

Messrs. Negretti & Zambra have made an attempt to harmonise the various scales by preparing an aneroid

FIGURE 200.

with a new dial, as shown in Figure 200. The outer scale is figured in centibars, and subdivided into millibars, and may be set to the altitude of the place. The next inner dial gives the actual pressure in millibars, whilst the two inner scales are divided into inches and tenths, and millimetres, and indicate the height of the mercury in an ordinary barometer.

MICROSCOPY.

By F.R.M.S.

Microscopical work, taken up as a relaxation, is no doubt mostly done in the winter; but we would like to point out, particularly to those who are beginning to study, that much interesting material can be collected in the open air during the summer. We therefore propose to publish a series of some notes and photo-micrographs bearing upon the subject by Mr. Harold S. Cheavin, whose name will be well-known to our readers.

I.—THE WATER-BEETLE (*DYTISCUS MARGINALIS*).—The savage Beetle of the pool, the diving Beetle, or the ferocious and carnivorous Beetle of the pool, are terms used by various writers in describing this familiar form of Beetle, so often met with in our country walks.

In the pools situated in quiet places, especially on the moor lands, the various forms of Water-beetle are found during the spring and summer months to be extremely abundant, either in the larval stage or as fully developed insects.

Darting through the water in quest of its prey, or rising to the surface, replenishing its air supply, the Water-beetle is seen to great advantage. The female insect, during the months of March and April, will be found to be very busy laying its eggs in small incisions made by the pointed ovipositor in the leaves and stems of water-plants, and in each incision only one egg is placed.

In about three weeks the eggs produce minute larvae, which grow very rapidly in the presence of an abundance of food, reaching full size—viz., two inches long—in four or five

FIGURE 201. Head and mouth organs of larva. × 32.

FIGURE 202. Larva of Water-beetle.

FIGURE 203. Tail-end of larva, with processes, spiracles, and tracheae. × 32.

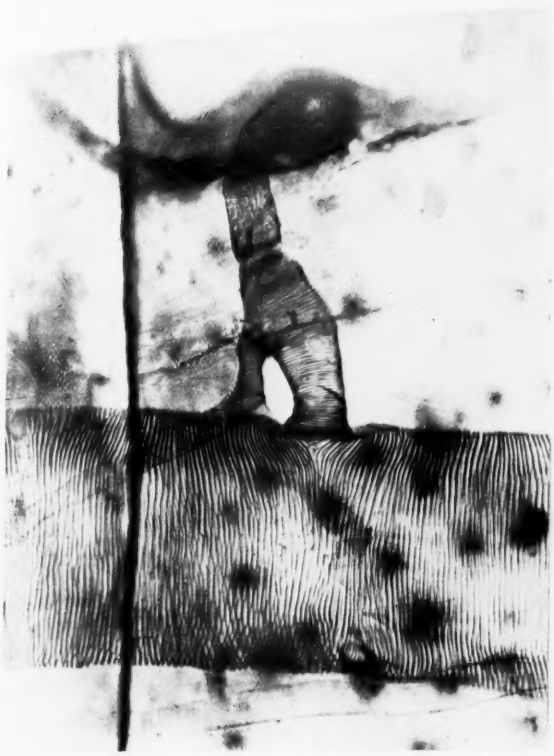

FIGURE 204. One of the main tracheal tubes of the Water-beetle larva, showing spirally thickened walls and how the tube branches, leading towards the closed spiracle. × 300.

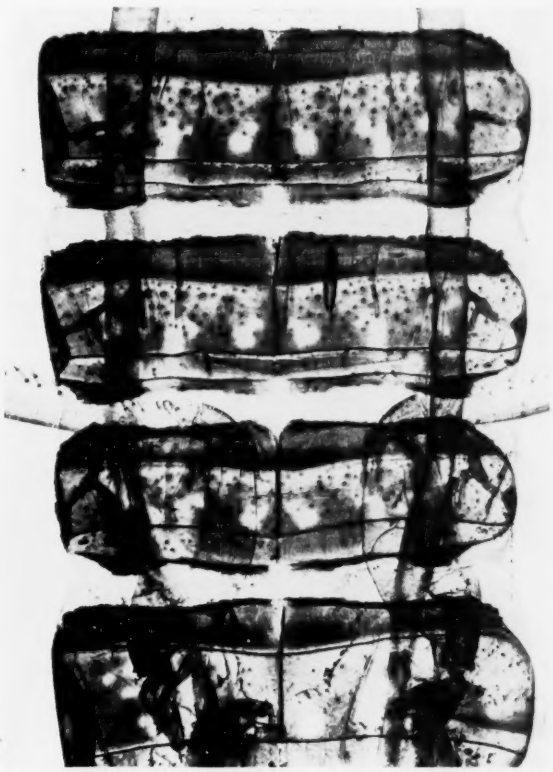

FIGURE 205. The two large tracheal tubes, arranged one on each side of the larva: they can be seen to come closer together at the base, and here they join the abdominal spiracles. × 60.

XUM

FIGURE 206. Antenna of Water-beetle. × 30.

FIGURE 208. The gizzard of a Water-beetle. ×30.

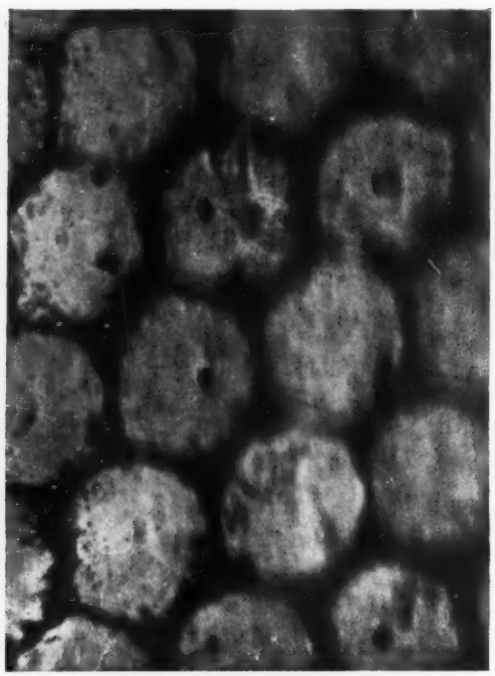

FIGURE 207. Part of the cornea of a Water-beetle's eye, showing the hexagonal areas known as "facets." × 800.

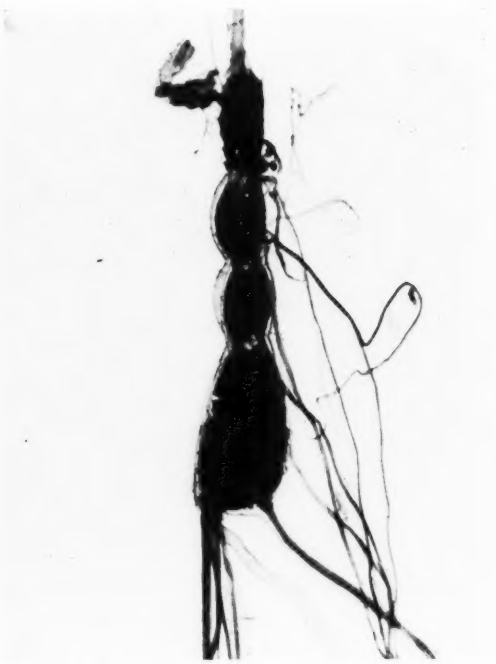

FIGURE 209. The main ganglion of a Water-beetle, showing nerve-threads attached. × 16.

weeks, each larval change in size being carried out by casting the chitinous covering.

When fully grown (see Figure 202) the larva is yellow-brown in colour, cylindrical in shape, and tapering to a point towards the tail-end; the head is very ferocious-looking, and is joined to the thorax by a distinct neck.

The mouth organs are very powerful, and the carnivorous impulses of the larvae cause them to play havoc amongst other inhabitants of the pond in which the larva lives.

Tadpoles, young fish, are all seized with great energy, once they come within the reach of the mandibles, and even other larvae, consisting of brothers and sisters, are quite welcome as food for this carnivorous aquatic larva. Thus, several larvae should never be placed in the same aquarium or amongst other larval forms of insect life, for in all cases only one inhabitant will be found as a survivor.

The mandibles (see Figure 201) are large, sharp, conical-shaped, claw-like organs, and are controlled at the base by powerful muscles. The prey is seized by these mandibles and pierced with the sharp ends, which make a small puncture in the body of the victim. The mandibles are hollow, and through a small hole, situated near the tip, the blood of the victim is sucked by means of the action of the pharyngeal pump, during which period the mouth is closed. The passage of the blood-flow from the victim can be seen by means of a microscope, and especially well if the blood is red, because the jaws and body of the larva are very transparent.

The mouth found between the lips (see Figure 202) is only used for devouring the solid pieces of the prey; the body of the victim is broken up by the mandibles, and the solid parts are then taken in.

The larva is lighter than water, and, to remain below, it is necessary for the mouth parts to grasp the stems of water-plants; to release hold, the jaws are relaxed, and the body of the insect at once rises to the surface of the pond. This rising to the surface is essential for breathing purposes. Like all other insects, the larva is dependent on air being taken into its body. The larva remains suspended by its tail from the surface-film of the water, and the air is taken in by two openings, known as "spiracles," situated at the extreme tip of the tail. These spiracles lead to the large longitudinal air-channels, one on each side of the body, known as "tracheae."

The two long processes found projecting at the tail (see Figure 203) are covered with very fine hairs, and serve to suspend the larva. Holding on to the surface-film of the water, they appear tubular, and one would imagine that air is taken in through these tubes; but this is not the case. The tracheae are long elastic tubes, and in the larva can be seen, one on each side, as black lines. These tubes have a spirally thickened inner layer of chitin, which keeps them always expanded (see Figure 204). A similar example can be found in garden hose or gas-tubes having internally a spiral wire, to prevent damage when the tube is trapped or suddenly bent on itself. Examination under the microscope shows that these tracheae branch off into smaller tracheae, and in the larvae lead to closed spiracles, the latter only becoming functional when pupation is complete. The spiracles in the larval body are arranged one on either side of each segment (see Figure 205).

The larva, on pupation, ceases taking in food, and seeks out some soft earth on the edges of the pond. Here it digs out a cavity, and works for twenty-four hours unceasingly. If the cavity be not finished, it will rest for the same period, viz., twenty-four hours, and recommence its labours, till the cell cavity is complete. When finished, the larva pupates in practically any position, and the change takes about fourteen days; the larval skin splits along the back, and the whole is cast off at the tail-end.

The period of pupation into the fully developed water-beetle varies somewhat, for in summer it lasts about fourteen days, but in winter it is very prolonged, and continues from any time up to spring. The exact period is at present an uncertainty.

The fully grown beetle eventually develops, and is seen to creep out of the burrow. At first its colour is very light, and it takes several days before the familiar dark-bronze appearance is assumed.

The adult water-beetle presents many new features, but the intense voracity and ferocity present in the larval stage are in no way diminished, and the carnivorous instincts are always present.

We have as a new feature the long antennae (see Figure 206), consisting of many-jointed conical-shaped parts, which seem to diminish in length towards the apex. Both the antennae, or feelers, as they are sometimes termed, are the same in both sexes of the insect; and as for their particular purpose their functions and use are at present undetermined, beyond the fact that, as in other insects, some sensory features are assumed to be possessed by them.

The eyes of the insect are very large, and protrude from each side of the head, immediately below the antennae (see Figure 207). As in many other insects, the eyes are of compound form, and consist of a very large number of hexagonal areas, known as facets: these facets in the Water-beetle produce multiple images.

When the cornea containing these facets is mounted flat, and the slide so prepared examined microscopically, the facets will be found to produce an image of a photograph in each area, under proper illumination; the image so obtained, however, is blurred.

In the eye of the insect the facets form the base of a pyramidal tube, and the apex is covered by a nerve sheath, which communicates the eye with the optic lobes of the brain ganglion (see later).

The pyramidal tube is covered also with a sheath, containing pigment grains, which serve to allow only straight rays of light, or central beams, to pass through the centre of the hexagonal area.

The nerve centres of the water-beetle are rather peculiar, and consist of ganglia, as they are termed, placed in the thorax and abdomen. In theory every segment of the body has one pair of ganglia; but by fusion and suppression the ganglia appear more complex.

The brain consists of three fused pairs of ganglia, divided into three divisions:—

(*a*) Parts forming optic lobes supplying the eyes;
(*b*) Parts supplying the antennae;
(*c*) Parts supplying the mouth and salivary glands.

Each division sends out nerve-threads; and, further, the ganglia in the other parts of the body appear to be made up of segments, having attached a large number of nerve-threads, which ramify in the various organs, such as those relating to movement (see Figure 209).

The gizzard, or crop, as it is better termed, is situated next to the oesophagus, and communicates finally with the rectum and anal glands. These parts, taken as a whole, form the alimentary canal of the water-beetle (see Figure 208). Food is stored or held in this crop, and practically the whole of the digestion is carried out here by means of the alkaline saliva, which converts the starch present in the food into sugar. The latter, being very soluble, is easily carried through the walls of the canal into the blood. An acid secretion is also passed forward into the crop from the ventricles, and this secretion emulsifies the fatty portions of the food and converts the albuminous products into peptones.

W. HAROLD S. CHEAVIN, F.R.M.S., F.E.S.

(*To be continued.*)

A FUNGUS-INFESTED MOSS.—The object of the present short article is to illustrate certain unlooked-for appearances which both interested and astonished the writer at the time, who now hopes they will prove of interest to the readers of "KNOWLEDGE." The specimen under observation was of the ordinary Wall Moss (*Tortula muralis*, see Figure 213), found growing in large numbers upon a brick fence wall in Finchley. After a piece had been placed in water upon the usual glass slip with a thin cover over it, the writer was astonished to see, after a time, the stem and urn of the moss break out in

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places into what seemed a violent irruption, as shown in Figure 210, under a two-inch objective. To the writer the scene was vastly realistic. It wanted but little imagination indeed to conceive the whole as a landscape, with volcanoes in the distance, craters and all; to conceive the observer as watching the irruptions from a point so far off that sound was swallowed up, still leaving the weird effects distinguishable to the vision. This may seem far-fetched, yet such was the impression conveyed, even to the point of forgetting that one was only looking at a moss through the microscope.

Recovering from the glamour, the first thought after was that here was something new in the life-history of the mosses; that not only did the urn partake, but also the supporting stem, in the production and emission of spores. This indeed would have been something of value to set before the scientific world. Second thoughts, however, due to appearances, soon convinced one that here was the work of an enemy, who had not only taken possession of his host, but had also destroyed him, and was now busily engaged in propagating his own kind. In other words, we were dealing with a fungus, and not a moss at all.

Substituting now another objective, and a power of five hundred diameters, the whole tracks of the eruptions were resolved into countless thousands of characteristic fungus spores. Of what particular genus they were the writer will not pretend to say, since this was only one stage of the life-history, neither is he learned in fungi. Figure 211 shows the appearance of the spores when first emitted; Figure 215, twenty-four hours after; and Figure 216, after three days.

It is stated by De Barry and others that the fungi differ from the green plant in the fact that although the complete organism in the first may be produced from a single spore, yet it is more often the outcome from a quantity of spores combining. Certainly they all seem, in Figure 216, as if working together for a common purpose, yet to what particular end further researches only could show. The theory of a colony will account for the enormous fecundity of spores in the fungi. The green plant, even the giant forest tree, is the product of one seed, or spore, only, while hundreds or thousands of spores may go to the making up of one fungus alone. It almost makes the mind reel while attempting to think this out; for here we are not dealing with consciousness as understood by us; yet each individual of this compound plant must be primed with the instinct to do the same thing, at the same time, at every stage of its development. Take the common mushroom, for instance. It remains underground, concealed from all eyes, while silently preparing for its last stage of reproduction; then suddenly shoots through in a single night, and effects its purpose.

May the writer here mention a little incident, of his own observing, as having some bearing upon the manner in which this apparent miracle is performed? Within a glass preserve jar, containing a vegetable infusion, a fungus also had intruded, which, from the after-effects revealed, was one that under normal conditions spent most of its life underground. There was great interest in watching its progress day by day, but one morning found it apparently missing. After a time, however, and much looking about, it was discovered at the end of a long stalk, leaning over the edge of the glass, seemingly much interested in what it saw there. The other end of the stalk still remained in the water, some two inches down. The head contained the spores, and, from further observation, what had happened was this: Each cell of the rudimentary stalk, thick before, had suddenly elongated, projecting the whole upwards until the head reached the top of the jar, and more. Surely, never since Alice in Wonderland found herself suddenly nine feet high, with her head struck against the roof of the hall, had there been such a transformation as this.

Figure 212 was taken from the urn of the moss, after the emission of the fungus spores. So entirely occupied had it been by the intruding enemy as now to be almost transparent, clearly showing the cells of the envelope. Some half-dozen protuberances, seen in profile only on the stalk, are here found scattered in plan over the surface of the urn, like so many miniature volcanoes. Each has a small round crater in the centre, through which the spores were ejected until all was emptied. How first formed does not come within the purview of this article. Indeed, the writer does not know, only that this was the prevailing feature in all the specimens examined; that only through them the spores were projected. From some only a few came, then suddenly stopped; from others they rushed out in great force, twisting about in corkscrew fashion, as shown in Figure 210.

Of course, it must be understood these demonstrations were only induced after the application of moisture. They point to this, however, that the parasite in question depended upon rain or dew for the delivery of its spores, in order to set out and infect other green plants. There is room for much moralising here, on the same rain falling upon both the just and the unjust, but the writer is merciful.

Figure 214 is from the urn of another specimen, showing a further growth of the mycelium outside, after the expulsion of the spores. In how far this is normal is a moot question. What it does prove is that the whole of the urn and stem is filled with it, to the destruction of the green plant. In some instances the spores of both fungus and moss were found within the same urn. Only one end could be expected from a mingling like this, but so far as the examination went the end was not yet. In conclusion, here is much interesting work for any microscopist prepared to carry the investigations further.

T. F. SMITH.

THE QUEKETT MICROSCOPICAL CLUB.—At the meeting of the Quekett Microscopical Club held on April 28th a new low-power substage condenser, calculated by Mr. E. M. Nelson, F.R.M.S., and made by Messrs. C. Baker, was described and exhibited. With top lens on, its focus is one inch, N.A. ·55; and with top off, its focus is two inches. A simple centring stop holder for dark ground illumination, which Mr. Nelson had designed, was also exhibited.

Mr. N. E. Brown, A.L.S., gave an account of "The Fertilisation of *Vinca minor*." The remarkable structure of the flower was described at length, and the extreme rarity of its fruit, both in this country and on the Continent, was mentioned. Nearly all the plants found in one locality are probably the products of one plant, and have not come from seed.

Mr. Jas. Burton (Honorary Secretary) read a note on, and exhibited a specimen of, "An Abnormal Form of *Arachnoidiscus ornatus*." The normal form resembles an ordinary "chip" specimen box. In the form under notice the sides of the "lid" remained shallow, as in the normal form, but the "sides," or, as it is usually called, the "girdle," of the bottom of the box is greatly elongated, giving the diatom, when viewed sideways, the appearance of a cylinder instead of little more than a disc. There is no indication that the unusual form is due to the beginning of the process of subdivision. In the normal forms the average depth is 30μ; in a case where subdivision was far advanced, 54μ. In two abnormal specimens the values were 96μ and 105μ respectively. The diameter in both normal and abnormal forms is practically constant, about a mean of 110μ. The abnormal form is only known to occur in one collection of material from Mauritius, and, even in that, the percentage is very small.

THE BINOCULAR MICROSCOPE.—It is doubtful whether any more interesting development in microscope construction has taken place in recent years than the reïntroduction of the binocular microscope in a form suitable for use with high, as well as low, powers. The binocular instrument has been used in this country for low-power biological work for many years; in fact, the Wenham binocular is still the favourite instrument among amateurs of a particular type. That the use of both eyes with any

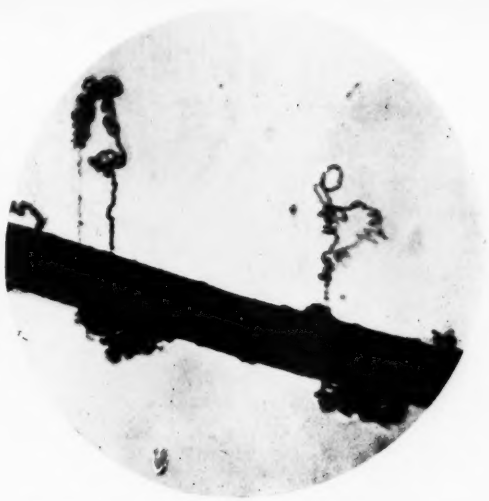

FIGURE 210. Stem of Figure 213 showing a miniature eruption of fungus spores.

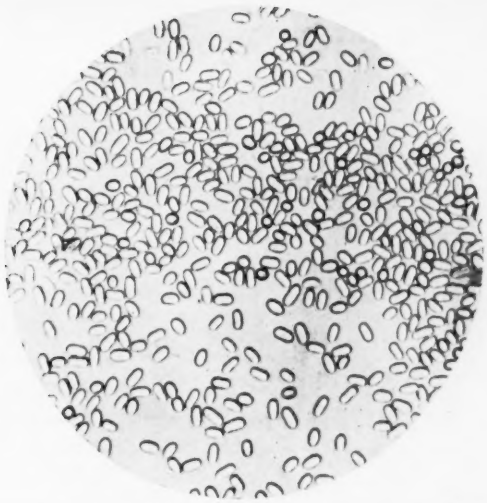

FIGURE 211. The fungus spores magnified 500 diameters at the time of eruption.

FIGURE 212. Urn of moss emptied of the fungus spores, showing the craters in plan.

FIGURE 213. *Tortula muralis* or allied species.

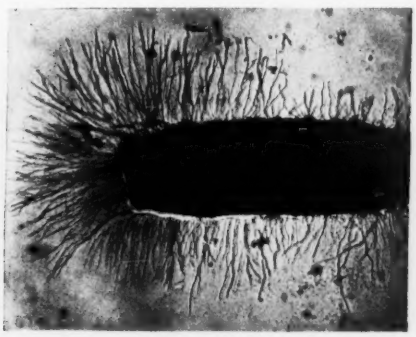

FIGURE 214. Urn of moss showing the growth of the inside mycelium after the ejection of the fungus spores.

FIGURE 215. Some of the spores seen in Figure 211 sprouting, after twenty-four hours.

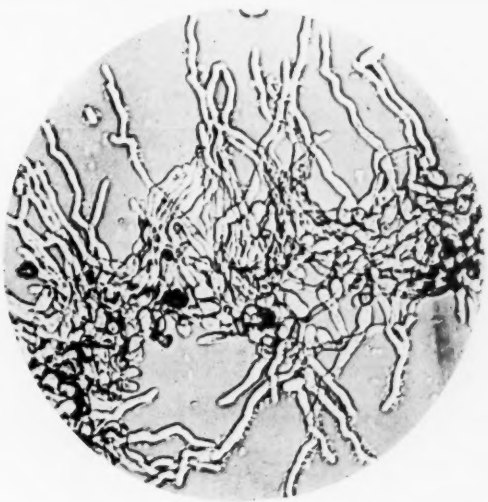

FIGURE 216. Growth from the spores (as in Figures 211 and 215) at the end of three days.

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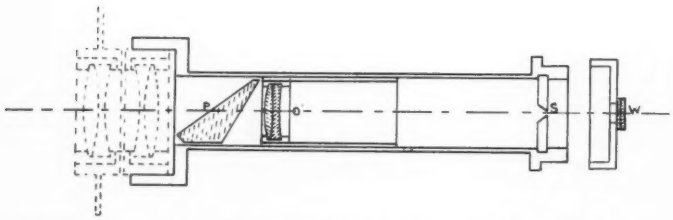

FIGURE 217. A simple Spectroscopic Attachment for converting an ordinary camera into a spectrograph. S, slide. O, small achromatic lens. P, dispersing system. W, neutral tint wedge.

FIGURE 218. Arc Spectrum of iron with lithium and sodium, between wave-lengths seven thousand and three thousand eight hundred. This photograph was taken with the apparatus shown in Figure 217.

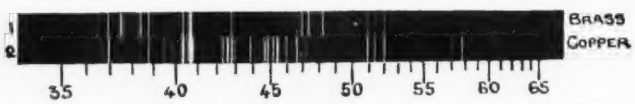

FIGURE 219. A Comparison Photograph of the arc spectra of copper and brass. The light coming from an unknown sample is allowed, first of all, to pass through the lower part of the slit, then the light from the standard through the upper portion by means of a sliding plate containing two apertures.

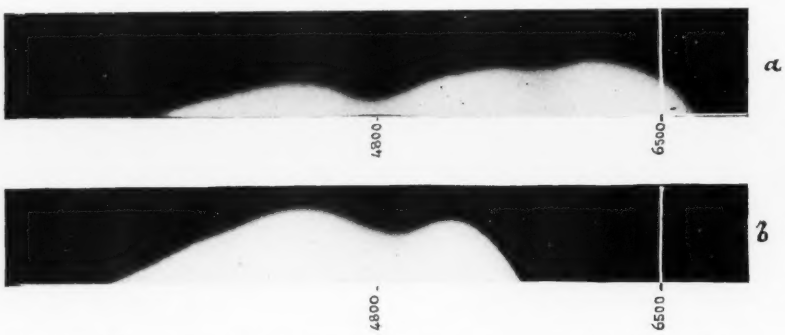

FIGURE 220. *a* is a photograph showing the sensitiveness of a plate made sensitive to red light. *b* shows the sensitiveness of an ordinary plate.

FIGURE 221. An original Phonographic Record on a disc 120 millimetres in diameter.

FIGURE 222. An enlargement by Monsieur Le Roy's method, of the disc shown in Figure 221 to 190 millimetres in diameter.

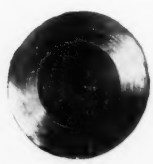

FIGURE 223. The Phonographic Record seen in Figure 221 reduced to 80 millimetres in diameter.

Figures 217–220 illustrate Mr. F. Stanley's note on "Simple Spectroscopic Apparatus" (see page 230).

Figures 221–223 refer to Dr. Gradenwitz's remarks on "Enlarging Phonographic Records" (see page 231).

optical instrument is an advantage of no mean order is beyond question, providing that no loss of accuracy of delineation results. The vision so obtained is not of necessity stereoscopic; in fact, in the form of binocular here referred to, and now being made by Leitz,* no claim is set forth under this head. The main advantage is that both eyes are used, so that no strain is thrown on either the one in use or the inactive one. All workers with the monocular microscope of any experience can use either eye for purposes of observation, while keeping the unused eye open. Many workers even then feel that the unused eye becomes fatigued, some even asserting that it suffers more than the one in use. By means of the binocular instrument this form of eye-strain is entirely avoided, and in addition any inequality of sensitiveness to colour appreciation, or to accuracy of observation of fine detail, is entirely done away with. In the form of instrument here described the two images are identical. The brightness of the fields of view should be exactly equal, but in actual practice some difference may be appreciated—a point, however, that is of very minor importance.

Figure 224 shows the general appearance of the instrument, the box-like attachment containing the system of prisms with the two eyepieces at its upper end. The separation of the latter can be adjusted, by means of a milled head, to suit the interocular distance of the observer. The distance apart can be varied between fifty-four and seventy-four millimetres, a millimetre scale indicating the correct setting to be made for observation. As the two eyes are generally of unequal strength, it was found necessary to fit an independent adjustment on one of the eyepieces. The usual way is to focus by coarse and fine adjustment, using the fixed eyepiece only, then the proper setting apart is given to the two eyepieces, and finally, if necessary, a further adjustment by the movable eyepiece is made. The internal arrangement of the prisms is shown in Figure 225. In the cemented prism nearest to the objective will be found a semitransparent coating of silver, which effects the physical division of the pencils of rays, one-half of the light passing through the silver film, and the other half being reflected.

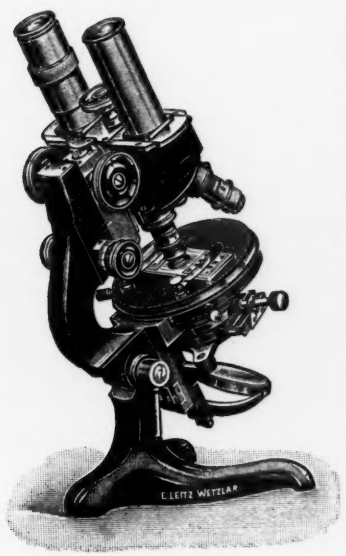

FIGURE 224.
The Leitz Binocular Microscope.

There is nothing novel about the arrangement of the prisms; on the contrary, it has been variously applied to optical apparatus in this and other modifications. It is technically possible to adjust the film of silver so that the transmitted and reflected beams are practically of equal intensity. The thickness of the glasses is chosen so that the lengths of the optical paths are equal to the right and to the left, thus securing equal magnification. The image is viewed by means of two parallel eyepieces, and this is perhaps the only point in the instrument that may give rise to criticism. In the original paper read before the Royal Microscopical Society the subject is dealt with quite fully, and the reasons for adopting the arrangement are indicated. In actual practice, however, there is no doubt that some observers are conscious of a slight temporary sensation of eye-strain after using the instrument, and the writer is one of those few. It may easily be that it arises, not from any fault in the instrument, but is due to the fact that the method of observation is a new one, calling into play unusual efforts on the part of the eye for accommodation and for convergence. If so, all that is needed to overcome any preliminary difficulty is practice and regular observational work. That the instrument constitutes an important advance in microscope construction is beyond question; in fact, it is hardly too much to say that for accurate research work, involving long periods of observation, it is likely to become, not merely advisable, but necessary. It is only those who have had occasion to work for long periods with a monocular, particularly in the study of biological processes, who can really appreciate the relief that the binocular brings. Messrs. Leitz are to be congratulated on initiating a new epoch in microscope design which, while it does not carry us any further, so far as increase of resolution is concerned, yet does place in the hands of the worker a method which will tend to enhance accuracy of observation.

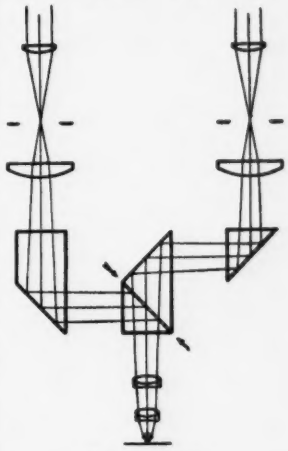

FIGURE 225.

J. E. B.

PHOTOGRAPHY.

By EDGAR SENIOR.

PHOTO-MICROGRAPHY BY MEANS OF SHORT-FOCUS PHOTOGRAPHIC LENSES.—Although microscope objectives having focal lengths of three, and even four, inches may be obtained, which are suitable for photographing comparatively large specimens at a low magnification, such as small shells, pieces of decayed wood, metal fractures, and such-like objects, it is in many respects preferable to employ short-focus photographic lenses, such as the planar and similar objectives made by Zeiss and other makers, since, these lenses being corrected for photographic purposes, there is no difference of focus to allow for, and, further, the ratio of their aperture to the focal length is such that they possess greater penetration or depth of definition, and at the same time the field is flatter. Then, again, when photographing insects, or anything where it is desired to include the whole of the object (especially when this is a large one), we are compelled to use such lenses, as no low-power microscope objective includes a visible area of the object greater than sixteen millimetres (five-eighths of an inch) in diameter. We have before us as we write a photograph of fossil wood from coal taken with a Zeiss planar, stopped down to F/11. The definition over the entire field is perfect: the vascular and cellular tissue—which leads to the inference that the greater portion of the vegetation that supplied the coal-beds belonged to the family of the firs—is well shown as a general view, and only requires further magnification with a higher power to become at once distinctly apparent. Lantern slides made from good negatives taken in this way become of great assistance either in class-teaching or in the more popular form of lecture. In taking these photographs the objective can either be employed attached to the camera and a supplementary stage used, in place of the microscope one, or the

* "The Binocular Microscope," by F. Jentzsch, *Journal of the Royal Microscopical Society.*

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lens can be attached to a funnel-shaped cone which can be screwed into the short-body tube of the microscope, but in no case is the eye-piece made use of. The latter method is perhaps preferable, with transparent objects, as then the illuminating apparatus attached to the sub-stage of the microscope can be utilised. With opaque objects it is a matter of indifference, as these must be lit by reflected light by one of the many methods in use for that purpose. If, for instance, it is desired to take a photograph of some sand, in order to show the character of any particular variety, or the nature of it generally, we may proceed as follows: On an ordinary 3×1 microscope slip of glass place a little white wax and melt over a bunsen or spirit lamp: this should then be spread evenly, and sprinkled over with the sand, which will be found to adhere well to its surface. Directly the wax is cool—which it does rapidly—a piece of dead black paper is placed upon the underside of the slide, when it is ready for examination in the microscope. The objective used in photographing may be a seventy-five millimetre (three-inch) planar, or similar lens, according to the magnification desired and the camera extension available. After the focusing has been satisfactorily performed, the burning of an inch or two of magnesium ribbon some little distance behind the objective will enable an exposure to be made, although it is better to employ a steady light, and some form of apparatus for concentrating it upon the specimen. No absolute rule can be laid down as to the illumination required, as so much depends upon the object itself and the particular points that it is desired to show most in it. Everyone must therefore exercise his own judgment in the matter; but it must be quite understood that even with low powers the images must be sharp and clear, in order that, if used as lantern slides, no defects shall be apparent when projected upon the screen. With regard to magnification, it often facilitates matters if we determine beforehand some definite linear magnification to make the image, and then, by the use of a formula for obtaining the conjugate foci, to place the focusing screen and the objective, and the latter and object, at the distance indicated, when the image will be practically in focus and of the size desired. Thus, suppose that we determine to make our image sixteen diameters as large as the object, and that a one-hundred-millimetre (four-inch) focus lens is to be used; then by the formula $v=(n+1)\,f$ we can find the distance at which to place the screen; and as the relation between the distance of image and its object from the lens is the same as that of their relative size, we can obtain the distance n at which to place the object from the lens to obtain an increase in size of sixteen diameters, the details of the calculation being as follows:— $v=(16+1)\,4=68$ inches.
and $n=68/16=4{\cdot}25$ inches.
Therefore, if we place the screen and object at these distances from the lens, the image will be approximately sharp, and will only require a little focusing to make it absolutely so. The position for any given magnification having been determined for each or any particular objective, the distance is noted, when by the use of a centimetre or millimetre scale the camera can be set almost instantly for the desired magnification.

PHYSICS.

SIMPLE SPECTROSCOPIC APPARATUS.—Spectrometers and spectrographs of the highest precision, as at present constructed for advanced research work, are necessarily expensive, as all the optical and mechanical parts must be of great perfection to give the required definition and accuracy; but for elementary spectroscopic analysis quite an efficient instrument can be obtained by converting an ordinary photographic camera into a spectrograph, which can be done at comparatively low cost.

Light can be decomposed by the use of either a glass prism or by a diffraction grating. The prism will produce a spectrum of greater light intensity than will the grating, but the spectrum will be abnormal, that is, the violet region will suffer a relatively greater dispersion for the same change in wave-length than the red. The diffraction grating, although giving a normal spectrum, is under the disadvantage that the available light is not all found in one spectrum, but is distributed over spectra of different orders, although often as much as half the light is found in the first order.

The spectrograph, in its simplest form, consists of a slit, collimating lens, prism or grating, and camera, and in simple instruments the camera generally entails the greatest expense. If, therefore, a photographic camera of hand or stand type has an objective of reasonably good definition, it should only be necessary to add the slit, collimating lens, and grating to convert the instrument into an excellent little spectrograph. The simplest method of accomplishing this is to employ, as dispersing system, a grating replica, mounted on a glass prism of the required angle to give approximately direct vision. The spectrum will not be a true grating spectrum, owing to the slight additional dispersion from the compensating prism, and allowance must be made for this when determining wave-lengths. The spectroscopic attachment can be arranged as in Figure 217.

The light passing through the slit, S, is collimated by the small achromatic lens, O, and after entering the dispersing system, P, a sharp spectrum is formed on the plate by means of the photographic lens. The lens, O, is mounted in a sliding tube, with scale, so that the focusing adjustment can be made more conveniently than by moving the photographic lens, especially in the case of hand cameras. The camera must be adjusted, however, so that objects beyond a hundred feet are in focus, or an excessive tilt to the camera back will be required to bring both ends of the spectrum into focus.

A spectrum photograph obtained with such apparatus, constructed by Messrs. Adam Hilger, Ltd., of Camden Road, is reproduced in Figure 218, and is the arc spectrum of iron, with lithium and sodium between wave-lengths seven thousand and three thousand eight hundred. The sodium lines are clearly shown separated on the negative.

Figure 219 is a comparison photograph of the arc spectra of copper and brass. The comparison photographs are obtained by exposing first the lower portion of the slit to the light coming from the unknown sample, and then the upper portion to the light from the standard, by means of a sliding plate with two apertures cut in it, and so arranged that the lower edge of one aperture is exactly in line with the upper edge of the other.

The range of spectrum obtained depends on the nature of the photographic lens employed, but will, with the majority of lenses, extend between wave-lengths eight thousand and three thousand six hundred. From wave-length eight thousand to six thousand, plates sensitive to the red must be used, and a filter must be placed in front of the slit to prevent the violet region of the second order overlapping the red of the first.

The instrument is extremely useful for determining the colour-sensitiveness of photographic plates by the wedge method of Dr. C. E. Mees (see *British Journal of Photography*, 1907). For this purpose, the neutral tint wedge, W (Figure 217) is mounted in front of the slit, and an incandescent gas or Nernst lamp used as light source. Such wedge photographs are shown in Figure 220 (*a* and *b*). *a* indicates the sensitiveness of a plate made sensitive to the red, while *b* indicates an ordinary plate. It will be noticed that both plates are comparatively insensitive at about wave-length four thousand eight hundred.

If in place of the neutral tint wedge there is employed a wedge cell, absorption photographs of dyes can be obtained in the same way. The deviation of the light caused by the liquid prism of dye is compensated for by filling the opposite side of the wedge cell with the solvent.

The spectroscopic attachment, when removed from the camera, can be used as a direct-vision spectroscope of high dispersion.

F. STANLEY.

ELECTRICAL NOMENCLATURE.—In a letter in which Mr. Thomas Coats, of Glen Tanar, Aboyne, N.B., advocates a revision of electrical nomenclature, it is suggested that a method of instruction, based upon the real existence of resinous electricity, would be of advantage to students. This kind of electricity he would call positive, and its defect negative. There is much to be said for this view. Who first called vitreous electricity positive and what guided his choice are questions of great historical interest in this connection.

ENLARGING AND REDUCING PHONOGRAPH RECORDS.—The only method so far available for enlarging or reducing phonograph records of the human voice or musical instruments, and thus augmenting or decreasing their sound intensity, was unable to ensure any satisfactory results. The groove traced by the phonograph style being enlarged (or reduced) by means of some pantograph arrangement, that is, by purely mechanical means, the unavoidable vibrations of the apparatus were bound to result in a more or less serious deformation of the original record.

In a paper recently submitted to the French Academy of Sciences, M. G.-A. Le Roy, of Rouen, describes a new process which, by purely physico-chemical means, obtains the same result, thus not only avoiding the above drawback, but affording a possibility of even improving the acoustic qualities of the record.

Whereas the original record is generally taken under conditions of increased sound intensity, and, accordingly, unavoidable disturbing noises, the new process, in fact, enables the original intensity to be reduced to rather moderate limits, any strengthening of sounds being afterwards obtained at will, and without any deformation, by enlarging the initial record. Moreover, the original phonogram, or, indeed, any enlarged reproduction, can be reduced to smaller sound intensity, and, accordingly, to a smaller compass, without any prejudice to its acoustic qualities.

Phonograph records are, according to M. Le Roy's process, enlarged by moulding with a substance capable of swelling, and reduced in size and intensity by moulding with a substance capable of contracting uniformly. It may be briefly described as follows :

Supposing a copper mould to have been obtained by galvanoplastic means from the original record in the wax of a gramophone plate. In order to enlarge this phonogram *a*, a mould is produced by means of a gelatine solution as concentrated as possible (thirty to fifty per cent. of dry gelatine). This gelatine mould, *b*, is placed in cold or slightly tepid water, possibly mixed with two to five per cent. salts, such as alum, and, if desired, acidulated with some acetic acid. As soon as the swelling of the gelatine is completed, the mould is made insoluble—and thus fixed—by dipping it into formolic water, and, after drying, is used in producing a solid matrix in wax, or any other plastic substance, which, in its turn, by galvanoplastic means, supplies the definite copper mould.

By repeating the same process over again, any desired enlargement can be obtained, a single operation supplying an up to three-fold enlargement.

In order, on the other hand, to reduce the original record, a mould is taken with gelatine as diluted as possible (ten to twenty-five per cent.), which is deprived of its water, either by immersion into alcoholic or concentrated aqueous solutions of salts, precipitating gelatine, or by drying in dry air, or in a vacuum. The gelatine mould, thus freed from its water, is used in the same way as above described, in obtaining an intermediate mould of plastical substance, from which the definite copper mould is prepared by galvanoplastical means. While several successive stages will allow any reduction to be obtained, a single operation supplies a linear reduction from 1 to 0·6.

In Figure 221, *a* shows an original record on a disc one hundred and twenty millimetres in diameter; Figure 222 is an enlargement to one hundred and ninety millimetres; and Figure 223, a reduction to eighty millimetres.

ALFRED GRADENWITZ.

ZOÖLOGY.

By PROF. J. ARTHUR THOMSON, M.A., LL.D.

INBREEDING IN RATS.—Dr. G. C. Bassett has found that the closest inbreeding in white rats was followed, after four generations, by a loss in brain-weight of from seven to ten per cent. on the average, and a loss in ability to form habits of about thirty per cent. on the average. But no further important degeneration of the stock occurred, even to the tenth generation of inbreeding.

DARKNESS AND DEPIGMENTATION.—Dr. A. M. Banta has been experimenting on the influence of cave conditions on animals introduced into them. He finds a progressive loss of pigment in mud minnows (*Umbra limi*), a crayfish (*Cambarus bartoni*), some salamander larvae, and a lot of wood-frog larvae. There is an Amphipod *Eucrangonyx gracilis*, an almost pigmentless form of which lives in caves in Central Indiana, while the normally pigmented form is abundant in the surface streams in the same region. It is interesting to find that experiments show the cave form to be less responsive to light and more responsive to tactile stimulation than its outside relative.

CATERPILLAR REARED BY ANTS.—F. Le Cerf reports on a remarkable association between a Lycaenid caterpillar and a colony of ants of the genus *Cremastogaster*. The case was discovered by MM. Alluaud and Jeannel on the Kikuyu escarpment. Certain acacias bear numerous nut-like galls, perforated by an orifice about one millimetre in diameter through which the ants go out and in. The caterpillar is about ten millimetres in length, and curiously onisciform or chiton-like. It bears remarkable modified hairs. Its mouth-parts suggest a vegetarian diet, and it probably feeds on the acacia leaves which the ants store. It could not possibly get out of the gall, and it must have been reared there by the ants.

NEW PARASITIC COPEPOD FROM A NOVEL HOST.—There is no end to the strange forms exhibited by parasitic Copepods, and one of the reasons, apparently, is that offshoots from many different non-parasitic Copepod stocks have drifted into parasitism, and that on many different hosts. Mr. G. P. Farran has recently described a new form, *Cholidya polypi*, from the arm-membrane of an Irish Octopus. It is in a way a parasite in the making, for its affinities with *Idya* are still obvious. It thus recalls *Balaenophilus*, which Aurivillius described from another strange habitat—the baleen plates of the blue whale. For *Balaenophilus* is another parasite in the making, with obvious relationship to *Harpacticus*, which is in the same family as *Idya*.

TREE KANGAROOS.—Albertina Carlsson has made an interesting study of *Dendrolagus dorianus*, one of the tree-kangaroos, which differ from the typical members of the family (Macropodidae) in not showing the usually conspicuous disproportion between fore limbs and hind limbs. It sometimes walks on the ground with both hands down, or with only one; it sometimes climbs with its hands gripping the branches. As in other members of the genus, the hairs of the neck are turned forwards, but it is peculiar to this species that the same is true of the hairs of the back. Some zoölogists maintain that all mammals, except Monotremes, have been derived from tree-climbing ancestors; but the anatomical facts in regard to *Dendrolagus* point to its derivation from terrestrial forms, secondarily arboreal.

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THE FACE OF THE SKY FOR JULY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 28.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°
July 2	6 42·4	N.23·1	13 54·1	S. 16·1	8 3·0	N.18·2	9 10·6	N.18·2	10 24·0	N.11·2	21 37·0	S.15·1	20 53·8	S. 18·2
,, 7	7 3·0	22·7	19 0·2	S. 26·9	7 59·3	17·1	9 34·0	16·3	10 35·1	10·0	21 35·6	15·3	20 53·2	18·2
,, 12	7 23·5	22·1	23 15·3	S. 3·7	7 48·8	16·6	9 56·8	14·2	10 46·2	8·8	21 34·0	15·4	20 52·4	18·3
,, 17	7 43·7	21·3	2 56·2	N.21·9	7 35·2	16·7	10 19·0	12·0	10 57·3	7·6	21 32·1	15·6	20 51·7	18·3
,, 22	8 3·8	20·4	7 34·2	N.25·4	7 23·7	17·3	10 40·7	9·7	11 8·5	6·4	21 30·0	15·8	20 50·9	18·4
,, 27	8 23·6	N.19·4	11 58·5	S. 2·2	7 19·5	N.18·3	11 1·9	N. 7·3	11 19·8	N. 5·2	21 27·7	S.16·0	20 50·1	S. 18·4

TABLE 29.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
July 2	− 2·4	+3·1	346·6	+19·6	−20·9	+0·3	121·8	55·6	8 40 *m*	8 23 *e*
,, 7	− 0·1	3·6	280·4	− 5·1	20·8	0·3	192·0	87·5	4 35 *e*	9 35 *m*
,, 12	+ 2·2	4·1	214·2	−21·5	20·7	0·3	262·1	119·5	4 50 *m*	6 38 *e*
,, 17	4·4	4·6	148·0	−16·2	20·6	0·3	332·3	151·6	10 36 *e*	7 49 *m*
,, 22	6·6	5·1	81·8	+ 8·1	20·5	0·3	42·5	183·6	10 50 *m*	4 52 *e*
,, 27	+ 8·7	+5·5	15·6	+22·1	−20·3	+0·3	112·7	215·7	6 46 *e*	3 59 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}4$, $9^h\ 55^m{\cdot}6$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN has commenced to move southward. Furthest from Earth $2^d\ 11^h e$. Its semi-diameter increases from 15′ 45″ to 15′ 47″. Sunrise changes from $3^h\ 48^m$ to $4^h\ 23^m$; sunset from $8^h\ 18^m$ to $7^h\ 49^m$. There is no real night early in July.

MERCURY is an evening star till the 16th, when it passes Inferior Conjunction and becomes a morning star. Semi-diameter increases from 5″ to 6″, then diminishes to 4½″. Illumination diminishes from $\frac{1}{5}$ to zero, then increases to $\frac{1}{5}$.

VENUS is an evening star, $\frac{3}{4}$ of disc illuminated. Semi-diameter 7″. The fact of its declination being south of the Sun impairs the conditions of observation for northern observers.

THE MOON.—Full $7^d\ 2^h\ 0^m e$. Last Quarter $15^d\ 7^h\ 32^m m$. New $23^d\ 2^h\ 38^m m$. First Quarter $29^d\ 11^h\ 51^m e$. Perigee $3^d\ 8^h m$. Apogee $15^d\ 3^h e$. Perigee 28^d noon, semi-diameter 16′ 15″, 14′ 48″, 16′ 12″ respectively. Maximum Librations, 4^d 7° N, 9^d 6° W, 19^d 7° S, 21^d 5° E, August 1^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 30).

MARS is advancing through Leo, 1° N. of ρ Leonis on 4th, ½° S. of χ Leonis on 18th. The semi-diameter during July diminishes from 2″·3 to 2″·1. The unilluminated lune is on the East: its width diminishes from ⅓″ to ¼″. The Planet is near Venus at the end of the month.

JUPITER is a morning star in Capricornus, nearing opposition. Polar semi-diameter, 22″.

Configuration of satellites at $0^h\ 30^m m$ for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
July 1	3	○	12	4●	July 17	324	○	1	
,, 2	3¼	○	4		,, 18	13	○	¾	
,, 3	32	○	14		,, 19		○	1234	
,, 4	1	○	324		,, 20	21	○	34	
,, 5		○	1234		,, 21	2	⊙	34	
,, 6	2	○	134		,, 22	3	○	124	
,, 7	1	○	34	2●	,, 23	31	⊙	4	
,, 8	3	○	124		,, 24	32	○	14	
,, 9	312	○	4		,, 25	13	○	24	
,, 10	3¾	○	1		,, 26		⊙	123	
,, 11	41	○	2	3●	,, 27	412	○	3	
,, 12	4	○	123		,, 28	42	○	13	
,, 13	42	○	3	1●	,, 29	43	○	12	
,, 14	4¼	○	3		,, 30	431	○	2	
,, 15	43	○	12		,, 31	432	○	1	
,, 16	3¾12	○							

The following satellite phenomena are visible at Greenwich, $1^d\ 1^h\ 26^m\ 12^s\ m$, IV. Oc. R.; $4^d\ 0^h\ 26^m\ 49^s\ m$, III. Oc. R.; $2^h\ 49^m\ 25^s\ m$, I. Ec. D.; $5^d\ 0^h\ 1^m\ 22^s\ m$, I. Sh. I.; $0^h\ 51^m\ 58^s\ m$, I. Tr. I.; $2^h\ 17^m\ 48^s\ m$, I. Sh. E.; $3^h\ 8^m\ 28^s\ m$, I. Tr. E.; $6^d\ 0^h\ 27^m\ 47^s\ m$, I. Oc. R.; $10^h\ 30^m\ 17^s\ e$, II. Ec. D.; $7^d\ 2^h\ 59^m\ 4^s\ m$, II. Oc. R.; $8^d\ 9^h\ 55^m\ 36^s\ e$, II. Tr. E.; $9^d\ 2^h\ 31^m\ 2^s\ m$, IV. Sh. E.; $11^d\ 3^h\ 53^m\ 0^s\ m$, III. Oc. R.; $12^d\ 1^h\ 54^m\ 57^s\ m$, I. Sh. I.; $2^h\ 37^m\ 19^s\ m$, I. Tr. I.; $11^h\ 12^m\ 22^s\ e$, I. Ec. D.; $13^d\ 2^h\ 13^m\ 25^s\ m$, I. Oc. R.; $10^h\ 40^m\ 8^s\ e$, I. Sh. E.; $11^h\ 20^m\ 21^s\ e$, I. Tr. E.; $14^d\ 1^h\ 4^m\ 45^s\ m$, II. Ec. D.; $15^d\ 10^h\ 57^m\ 8^s\ e$, II. Sh. E.; $16^d\ 0^h\ 14^m\ 17^s\ m$, II. Tr. E.; $18^d\ 1^h\ 14^m\ 26^s\ m$, III. Ec. D.; $19^d\ 3^h\ 48^m\ 40^s\ m$, I. Sh. I.; $20^d\ 1^h\ 6^m\ 50^s\ m$, I. Ec. D.; $3^h\ 58^m\ 19^s\ m$, I. Oc. R.; $10^h\ 17^m\ 9^s\ e$, I. Sh. I.; $10^h\ 48^m\ 1^s\ e$, I. Tr. I.; $21^d\ 0^h\ 34^m\ 8^s\ m$, I. Sh. E.; $1^h\ 5^m\ 1^s\ m$, I. Tr. E.; $3^h\ 39^m\ 22^s\ m$, II. Ec. D.; $10^h\ 24^m\ 26^s\ e$, I. Oc. R.; $22^d\ 10^h\ 38^m\ 39^s\ e$, II. Sh. I.; $11^h\ 36^m\ 8^s\ e$, II. Tr. I.; $23^d\ 1^h\ 33^m\ 59^s\ m$, II. Sh. E.; $2^h\ 31^m\ 18^s\ m$, II. Tr. E.; $25^d\ 8^h\ 42^m\ 2^s\ e$, IV. Sh. E.; $26^d\ 0^h\ 34^m\ 55^s\ m$, IV. Tr. E.; $27^d\ 3^h\ 1^m\ 23^s\ m$, I. Ec. D.; $28^d\ 0^h\ 11^m\ 4^s\ m$, I. Sh. I.; $0^h\ 31^m\ 56^s\ m$, I. Tr. I.; $2^h\ 28^m\ 16^s\ m$, I. Sh. E.; $2^h\ 49^m\ 6^s\ m$, I. Tr. E.; $9^h\ 30^m\ 4^s\ e$, I. Ec. D.; $10^h\ 43^m\ 52^s\ e$, III. Sh. E.; $29^d\ 0^h\ 3^m\ 51^s\ m$, III. Tr. E.; $0^h\ 8^m\ 36^s\ m$, I. Oc. R.; $8^h\ 56^m\ 49^s\ e$, I. Sh. E.; $9^h\ 15^m\ 4^s\ e$, I. Tr. E.; $30^d\ 1^h\ 15^m\ 35^s\ m$, II. Sh. I.; $1^h\ 52^m\ 0^s\ m$, II. Tr. I.; $4^h\ 10^m\ 47^s\ m$, II. Sh. E.; $31^d\ 10^h\ 54^m\ 20^s\ e$, II. Oc. R.

The eclipses will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN and NEPTUNE are too near the Sun for convenient observation.

URANUS is a morning star.

COMETS.—See "Notes on Astronomy."

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
May-30 Aug	333	+ 28	Swift, streaks.
May-July ...	252	− 21	Slow, trains.
June-Aug. ...	310	+ 61	Swift, streaks.
June-Sept. ...	335	+ 57	Swift.
June-July ..	245	+ 64	Swift.
June-Aug. ...	303	+ 24	Swift.
July 6-22 ...	284	− 13	Very slow.
July 15-31 ..	23	+ 43	Swift, streaks.
July 19 ...	315	+ 48	Swift, short.
July 22-27 ..	335	+ 51	Swift, streaks.
July-Aug. ..	308	− 12	Slow, long.
July 25-Sept. 15	48	+ 43	Swift, streaks.
July 28 ...	339	− 11	Slow, long, conspicuous shower, the July Aquarids.
July-Sept. ...	335	+ 73	Swift, short.
July 8-31 ...	317	+ 31	Swift, white.
July-Aug. ...	280	+ 57	Slow, short.
July-October...	355	+ 72	Swift, short.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 31).

TABLE 30. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reäppearance. Time.	Reäppearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
July 3 ...	Wash. 965	7·2	9 15 *e*	79	—	—
,, 7 ...	Wash. 1220	6·8	0 50 *m*	79	—	—
,, 12 ...	82 Aquarii	6·4	1 11 *m*	88	2 15 *m*	199
,, 13 ...	Wash. 1584	7·3	—	—	1 56 *m*	256
,, 15 ...	Wash. 65	6·9	—	—	0 7 *m*	216
,, 15 ...	Wash. 69	6·6	—	—	1 50 *m*	193
,, 17 ...	μ Arietis	5·7	1 13 *m*	37	2 7 *m*	270

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

TABLE 31. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
o Herculis	18 4	+28 ·7	4·1 to 4·4	β Lyrae Star?	
WZ Sagittarii...	18 12	−19 ·1	7·7 to 9·2	21·7	June 30.
W Lyrae	18 12	+36 ·6	7·3 to 12·5	196⅓	June 25.
Y Sagittarii	18 16	−18 ·9	5·8 to 6·6	5·7734	
d Serpentis	18 23	+0 ·1	4·9 to 5·6	irregular.	
R Lyrae	18 53	+43 ·8	4·2 to 5·1	irregular.	
R Sagittarii	19 12	−19 ·5	7·0 to 13·0	269	May 11.
AF Cygni	19 28	+46 ·0	6·9 to 8·0	94	May 22.
RT Aquilae	19 34	+11 ·5	7·4 to 13·5	325	July 26.
R Cygni	19 35	+50 ·0	5·9 to 13·8	425·9	April 28.
η Aquilae	19 48	+0 ·8	3·6 to 4·2	7·1764	
Z Cygni	19 59	+49 ·8	7·1 to 13·8	263	July 24.

Principal Minima of β Lyrae July $12^d\ 5^h\ m$, $25^d\ 3^h\ m$.

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REVIEWS.

ASTRONOMY.

Fall of a Meteorite in India.—By J. COGGIN BROWN. From the Records of the Geological Survey of India. Volume XLIII. Part 3. Calcutta.

Although actual falls of meteorites, or aërolites, appear to be more commonly witnessed in India than in Europe, yet even in the former country such events are of comparatively rare occurrence, so that each one has a special interest of its own. Such falls are, of course, much more commonly witnessed by natives than by Europeans, and in such cases, if the specimens are to be saved for science, prompt action is essential, as otherwise the villagers who may have seen the fall usually consider it in the light of a supernatural manifestation, and may not infrequently build an inviolable sanctuary over the site where the fragments fall.

A recent event of this nature was recorded in *The Statesman*, Calcutta, of January 18th, 1913, in the following words :—

" A correspondent notes from Mussoorie : On Sunday, the 12th instant, at about 6 p.m., a strange phenomenon occurred, when suddenly the whole place became a blaze of light, which was almost blinding to the eyes. On observers looking up for the cause, they saw a large ball of fiery substance similar to large cannon-balls, travelling from north-west to south-east, throwing out sparks. It suddenly burst with a fearful report, followed by two similar reports, as if cannons were being fired. This was followed up by continual reports, as if a *feu-de-joie* was being fired, which lasted for fully ten seconds."

To the officials of the Geological Survey of India this account at once suggested the fall of a large meteorite, fragments of which might have struck the Earth in the neighbourhood of Dehra Dun and Mussoorie. A communication was consequently made forthwith to the Superintendent of The Dun, requesting that immediate steps might be taken to recover any such fragments. No time was lost, and, as we learn from a report by Mr. J. Coggin Brown, in Volume XLIII, Part 3, of the *Records of the Geological Survey of India*, it was soon ascertained that one Daya Ram, the *Mukhia* of Banswal, a hamlet about ten and a half miles from Mussoorie, had a few pieces of the meteorite carefully wrapped in a cloth in his house. These he was induced by the Sub-Divisional Officer of the district to hand over, and they are now safely housed in the Offices of the Geological Survey of India in Calcutta, where they have been subjected to a chemical analysis, which has proved of considerable interest to mineralogists.

Daya Ram's story, as told to the Sub-Divisional Officer, is as follows: On the evening in question the narrator, on seeing the light and hearing the accompanying reports, stepped hastily outside his house-door, and, while standing there, was immediately made aware of some body falling close behind his ear, and then striking a rock embedded in the ground some five feet distant from the hut. The force of the impact was such that the falling body was shivered into small fragments, one of which struck a wooden vessel about a couple of feet in height of the type commonly used in the hills for carrying oil and other liquids. Procuring a light, as it was too dark to make an effective hunt without one, Daya Ram proceeded to institute a regular search for other fragments. This, however, had to be postponed till the following morning, when a mark was observed on the smitten rock, and several fragments, spread over a distance of about twenty feet, were collected.

It may be added that the fall of this aërolite was witnessed, from a spot near the Grand Central Hotel, Mussoorie, by the Sub-Divisional Officer himself, who heard " a noise as of something large rushing through the air "—an accompaniment of the fall not mentioned in *The Statesman's* account.

R. L.

BOTANY.

British Flowering Plants (Volume I).—By MRS. HENRY PERRIN. 177 pages. 66 coloured plates. 12-in. × 10½-in.

(Bernard Quaritch. Price 15 guineas net for the 4 volumes.

For many years Mrs. Henry Perrin has devoted much of her leisure to making accurate drawings in water colour of British flowering plants, and the book, of which we have received the first volume, is the outcome of a desire that Mrs. Perrin's work should be preserved in some readily accessible form. The drawing which we, by permission, reproduce here (see Plate I, facing this page) of the Marsh Marigold (*Caltha palustris*) will show the artistic merit of the drawings, the care with which the various parts of the plant are illustrated, and the success with which the Menpes Printing and Engraving Company have reproduced the originals in four colours. We should note that this illustration appears in the second volume.

Professor Boulger, who knows how to bring forward his facts in an attractive manner, has written the introduction and the descriptions of the figures, which include a number of drawings of floral dissections. It has only been possible to make a selection of Mrs. Perrin's drawings, or otherwise the book would have run into a very large number of volumes, and the expense of producing it would have been too great. It will be evident, however, to those who know something about the production of plates that not only time and patience, but much money, must have been lavished upon the book. In all, there will be three hundred coloured illustrations, and these have been made as representative as possible. The Grasses and Sedges have been omitted, and some minor families of Water Plants.

Volume I consists of an introduction, already mentioned, which deals with the terms used in describing the leaves, roots, and flowers, which may serve to make more intelligible the notes on the different species ; and it must be said at once that these, as a rule, explain themselves, for Professor Boulger, no doubt realising that many of those who take up the book will do so because they are attracted first of all by its artistic side, has been at considerable pains to explain many terms which he uses as he goes along. The volume deals with Gymnosperms, Monocotyledons, and twelve families of Dicotyledons.

Only a thousand copies of the complete work will be printed. Those who are fortunate enough to obtain one will have something to be proud of, and we confidently advise every lover of flowers whose purse is deep enough to make a point of buying a copy of " British Flowering Plants."

W. M. W.

Physiological Plant Anatomy.—By DR. G. HABERLANDT, translated from the German by MONTAGU DRUMMOND. 777 pages. 291 figures. 9-in. × 6-in.

(Macmillan & Co. Price 25/- net.)

On three occasions Professor Haberlandt has revised his book on plant anatomy, and the present work is a translation of the fourth German edition. The scheme of the book is to consider structure along with function. The whole subject is gone into in great detail, and some idea of this may be gained from the statement that such points as the administrative function of the nucleus, the production of wound cork, the absorption of water by leaves, and the curious structures called eel-trap hairs, developed in connection with the relation of plants and crawling insects, and furnished with special locking devices, are dealt with and described. A very interesting paragraph is that concerned with annual rings. The transverse section of the plank root of *Parkia africana*, which the author brought back with him from Buitenzorg, has a total vertical

diameter of 140 centimetres, but the organic centre is 92 centimetres distant from the upper surface, and therefore only 12 centimetres from the lower surface of the root. Epinasty, as it is called, is not much in evidence in the zone represented by the first twelve annual rings, which amount in all to 9 centimetres on the upper and 6·5 centimetres on the lower side, but the thirteenth annual ring initiates the subsequent prodigious development of the upper half. Those who are fond of structural botany will find in "Physiological Plant Anatomy" information and material which appeals specially to them, that is not too common in other books on the subject in our language.

W. M. W.

My Garden in Spring.—By E. A. BOWLES, M.A. 308 pages. 40 plates. 9-in. × 6-in.

(T. C. & E. C. Jack. Price 5/- net.)

As regards its production, this book is an excellent example of modern printing and illustrating in half-tone and in colour. Its appearance also points to the great interest which is now taken in gardens, and it contains much of value to the would-be horticulturists who read what the author thinks and does. They may not trouble to criticise the style of writing, or be worried by the occasional affectation or attempts at humour which they meet. We feel constrained to point out, however, that "the lunatic asylum" which gives its name to one chapter is not the house in which the author lives, but only a part of the garden where teratological specimens are grown. We are pleased that some visitors to Mr. Bowles's garden have said that it is too much like a museum, because this shows that he grows plants of botanical as well as horticultural interest. We should much like to know, however, why Mr. Reginald Farrer, who contributed the preface, should describe Sir Frank Crisp's rock-garden in such a way that anyone who has been privileged to see it could not fail to recognise it, and at the same time go out of his way to ridicule it.

W. M. W.

CHEMISTRY.

A New Era in Chemistry.—By H. C. JONES. 326 pages. 8½-in. × 6-in.

(Constable & Co. Price 8/6 net.)

The striking development that has taken place in the science of chemistry during the last twenty-five years, beginning with the far-reaching generalisations of van 't Hoff upon the analogy between osmotic pressures in gases and solutions, and the theory of electrolytic dissociation of Arrhenius justify the author's claim that a new epoch began in 1887. Prior to that time chemistry was still, to a large extent, the storehouse of many isolated facts and observations which required the use of several keys before they could be placed in their proper compartments. To quote Professor Jones's description, chemistry was then passing through the stage of systematisation, and had not yet become a science.

In this book we have a readable account of the more important developments during this period, and the author not only summarises the results of the work, to which he himself has been an important contributor, but also gives us intimate glimpses, at first hand, of the personalities of many of the men who have done the work.

The last chapter deals with our present knowledge of the electrons and radio-chemistry, and it is interesting to note that Professor Jones apparently concurs with the view, expressed many years ago by Ostwald, that energy is what we know, and that the existence of matter is purely hypothetical. Upon the question of the transmutation of the elements, under the influence of radio-activity he suspends judgment.

This is a book to read, not once, but many times, for it is full of interest for the chemist, and for all who have even a slight knowledge of chemistry. There is a good index, but the book would gain in value as a work of reference by the addition of a classified bibliography. C.A.M.

Physical Chemistry and Scientific Thought.—By W. C. McC. LEWIS, M.A., D.SC. 20 pages. 8½-in. × 5½-in.

(Liverpool: The University Press. Price 1/- net.)

This booklet contains Professor Lewis's inaugural lecture, delivered at the University of Liverpool on Friday, January 16th, 1914. The major portion of the lecture is concerned with the question of the nature of Science. Professor Lewis regards Science as a particular branch of Philosophy, and deprecates the view that Science and Philosophy are sharply distinguished from, and, in a manner, opposed to, each other. As he says, the primary object of any science is generalisation, and, so far as Chemistry and Physics are concerned, what is meant by the explanation of any phenomenon is its re-statement in terms of mechanics. Concerning this he writes: "By re-statement I do not mean the mere use of alternative terms, but rather the demonstration that the existence of the phenomenon is to be anticipated on the basis of a series of logical mechanical theorems (which we have reason for regarding as true), often with the addition of something which we find necessary as a connecting link, and to which we give the name of assumption, or hypothesis." The force of the word "logical" in the above statement is not, I think, quite obvious. The theorems of mechanics are just as much inductive laws as those of the other sciences, and carry no logical or *a priori* necessity. But Professor Lewis, on the other hand, definitely repudiates the narrow materialism of the past century. He closes his lecture with some interesting and instructive observations on scientific research, which should be read by those who feel called to a life devoted to the quest of knowledge of Nature.

H. S. REDGROVE.

GEOLOGY.

Textbook of Palaeontology, Volume I.—Edited by C. R. EASTMAN, M.A., PH.D., adapted from the German of Karl A. VON ZITTEL. Second Edition. 839 pages. 1600 illustrations. 9-in. × 6-in.

(Macmillan & Co. Price 25/- net.)

The second edition of Professor C. R. Eastman's textbook, adapted from the German of von Zittel, is naturally much larger than the first edition published in 1900. It has 839 pages, as compared with 706, and 1600 illustrations, as against 1476 in the old edition. There is also a much longer list of collaborators, amongst which only the names of J. M. Clarke, W. H. Dall, and C. Schuchert appear in the 1900 list. There are naturally, therefore, considerable differences of treatment of the several phyla as compared with the 1900 edition; differences, however, which reflect the great advances of the intervening thirteen years. Parts of the work have been entirely rewritten and rearranged, and the classification in many groups has been completely altered. The book can hardly, therefore, still be regarded as von Zittel's textbook, although in scope and style it is broad-based upon Zittel's great foundation. It is still emphatically a textbook for the advanced student, and we should have welcomed, whilst acknowledging the value of the general introductory chapter, a section on methods of research and on the troublesome questions of nomenclature and priority. One can hardly do enough justice to the beauty of the illustrations and the general production of the book. It has been done with extraordinary care and thoroughness.

G. W. T.

The Birmingham Country: Its Geology and Physiography.—By C. LAPWORTH, F.R.S. 53 pages. 2 maps. 8¼-in. × 5½-in.

(Birmingham: Cornish Bros. Price 1/-. With maps, price 2/6.)

This little book has had two precursors, one written for a previous visit of the British Association to Birmingham, in 1886, and the other for an excursion of the Geologists' Association in 1898. It is reprinted from the handbook published for the Birmingham Meeting of the British

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Association in 1913, and, as might be expected from the retired Professor of Geology at Birmingham University, it is a most complete, readable, and up-to-date account of the geology of an interesting district. The Birmingham country is described as a "sea of Triassic deposits, which fill up to one general level the hollows in a most irregular basin, or old land-surface, carved out of Palaeozoic rocks." The stratigraphy, whilst constituting the major portion of the work, is supplemented by sections on the physiography, tectonics, glaciology, and geomorphology of the area. The value of the book is greatly increased by two excellent maps—one geological, the other topographical—on the scale of two miles to the inch, and covering an area of two thousand five hundred square miles. There is also a bibliography of the more important geological works on the Birmingham district. The geologist coming fresh to the Midlands could not have a better introduction than Professor Lapworth's comprehensive and well-printed book.

G. W. T.

Guide to the Geology of the Whitby District. By LIONEL WALMSLEY. 37 pages. Illustrated. 6½-in. × 4¼-in.

(Whitby: Horne & Son. Price 1/- net.)

This is a smaller and less ambitious work on areal geology than Professor Lapworth's, reviewed above. Its title is slightly misleading, since only the coast sections are described, and no attempt is made to deal with aspects other than stratigraphical and palaeontological. The coast is treated in five sections, which comprise a popular account of the rocks and the fossils they contain, with many valuable hints as to their discovery and method of collection. Many of the common fossils are illustrated usefully, if somewhat crudely, and a sketch-map of the Liassic zones in Robin Hood's Bay is inserted. There are one or two misprints and grammatical slips, and a reference to rhombohedral pyrites (page 28), which should be revised in any future edition. Also, the printer has made a hash of the chemical formulae on page 25. The geological visitor to the beautiful and interesting Whitby coast will find the local information given by this little guide distinctly useful for fossil-hunting, and for making a first survey of the geology.

G. W. T.

ORNITHOLOGY.

The Wonders of Bird Life.—By W. PERCIVAL WESTELL. 128 pages. 24 Figures. 7½-in. × 5-in.)

(Manchester: Milner & Co. Price 1/– net.)

Mr. Percival Westell has studied birds for many years, and he has put together in a small compass many interesting points with regard to these creatures, chiefly, we imagine, for the benefit of beginners and for young people; for he tells how to study birds, touches lightly on their flight, wonders of migration, methods of protection, and economic importance. What is more, he indicates how much still needs to be found out, while he offers advice on the putting up of nesting-boxes, and on the study of birds in school grounds and gardens. A chapter dealing with "Bird Names," by the late Dr. W. T. Greene, brings to a close a book which ought to do a great deal of good.

W. M. W.

ZOÖLOGY.

Report on a Zoölogical Mission to India in 1913.—By CAPTAIN S. S. FLOWER. 100 pages. 12 plates. 9¼-in. × 6½-in.

(Cairo: Government Press. Price 5/–.)

Captain Stanley Flower last year paid a visit to India, in order to see the various Zoölogical Gardens belonging to Maharajas, the Government, and different municipalities. He collected together much information of particular value to those in charge of collections of living animals, and also to zoölogists in general. These notes he has published in a report, which we commend to our readers. It contains notes on the sizes of elephants, on the colour of their eyes, and on the details with regard to Indian crocodiles. The great tank, seventy-two acres in extent, built near Ahmedabad by the king of that place in the year 1452, is of special interest owing to the island in it, which is laid out as a garden, and forms a sanctuary for birds, which are remarkably tame, and show little fear of mankind. Another point of interest is the enclosure built by the late Maharaja of Alwar, circular in plan, and so arranged that the tigers which are kept in it appear to be at liberty as one approaches it when driving into the palace or walking in the park. Captain Flower also deals with administration and some museums. The plates include interesting pictures of giraffes, elephants, and tapirs.

W. M. W.

GIRDLING THE EARTH WITH SOLAR OBSERVATORIES.

By MARY PROCTOR.

(*Daughter of the late R. A. Proctor.*)

THROUGH the munificence of Mr. Thomas Cawthron, of Nelson, N.Z., who is giving £50,000 for the purpose of building, equipping, and endowing a Solar Observatory in Nelson, another link will be made in the chain of such observatories girdling the Earth. This is a project of vast importance, since it will enable men of science to keep the Sun under continuous observation for the whole twenty-four hours. Rapid changes are constantly taking place on the surface of the Sun, such as vast upheavals and disturbances in the spot-centres known as sunspots. Moreover, a curious connection between sunspots and the Earth has been detected, especially with regard to magnetic storms. As the central body of the solar system, controlling the motions of the planets, and making life possible upon the Earth, the Sun is well worthy of careful investigation.

According to Professor G. E. Hale, Director of the Solar Physics Observatory at Mount Wilson, California, "a permanent decrease of one hundred degrees (about 0·6 per cent.) in the effective temperature of the Sun is considered by good authorities to be sufficient to produce another Ice Age on the Earth. So great a change could hardly occur; but smaller variations due to internal causes, or to modifications in the absorbing power of the Sun's atmosphere, are very probable. Since solar phenomena follow more or less definite cycles of change, a better understanding of them might conceivably permit variations in its radiating power, sufficient to determine seasons of good or bad harvest, to be in some degree anticipated. The importance of solar research from this standpoint is thus sufficiently obvious."

According to observations made by St. John at Mount Wilson, the region in the lower atmosphere of the Sun, including the lowest levels of the reversing layer, and especially the underlying gases, is the region of tremendous disturbances in which the upper portion of the sunspot vortex is located, in which occurs the outflow of material from the interior of the Sun. Above this turbulent region, yet more or less involved in its activities, is the general reversing layer, whose normal condition seems to be one approaching more nearly a stable state. The chromosphere seems quite sharply distinguished from this region, both in its composition and in the movements of its constituent gases near spots.

In the case of storms in the solar atmosphere the point of observation is from the outside, and the upper movements are those directly detected. In the case of terrestrial cyclonic storms but little is known from direct observation of the atmospheric movements over the centre of the storm. Therefore, by means of a chain of solar observatories around the Earth, it would be interesting if our knowledge of cyclonic storms here could be supplemented by continuous observations of such storms on the Sun.

NOTICES.

THE LARVAL EEL.—Mr. Hugh M. Smith, the United States Commissioner of Fish and Fisheries, contributes to *The Guide to Nature* (the organ of the Agassiz Association) an interesting article entitled "The Mysterious Life of the Common Eel."

SCIENTIFIC MEETINGS OF THE ZOÖLOGICAL SOCIETY.—As a result of a post-card ballot, it has been decided that in the new session beginning in October, 1914, the meetings for scientific business shall be held in the afternoons of Tuesdays at 5.30 p.m.

SUCCESS IN PHOTOGRAPHY.—A pamphlet entitled "Simplicity and Success in Photography," which Messrs. Burroughs Wellcome, of Snow Hill Buildings, E.C., will send gratis on request, contains a photograph of Captain Scott's ship, the "Terra Nova," developed by Mr. H. G. Ponting in the Antarctic with tabloid Rytol Universal Developer.

OXFORD UNIVERSITY OBSERVATORY.—The thirty-ninth annual report of the Savilian Professor of Astronomy to the visitors of the University Observatory for 1913-14 contains a list of the names of the Staff and a detailed account of the teaching and research work done, as well as the publications issued.

"PROBLEMS OF SCIENCE."—The Open Court Company, of 149, Strand, have nearly ready for publication an English version of "Problems of Science," by Federigo Enriques, Professor in the University of Bologna. This authorised translation has been made by Katherine Royce, while Professor Josiah Royce, of Harvard University, has contributed an Introduction.

THE BINOCULAR MICROSCOPE.—We are sorry that in our last issue, owing to a slip of the pen, we were far from doing justice to Mr. Leitz's new binocular microscope. What we said was that the microscope was capable of being used for all purposes to which the "binocular" is put. We should, of course, have said "*monocular*," which is a very different thing.

THE EAST AND WEST UNION.—At the International Club on May 22nd an Association was established, under the title of "The East and West Union," for the promotion of cordial relations among the divisions of mankind, without regard to race, colour, or creed, and in particular to encourage a good understanding between East and West. The address of the Provisional Secretary is 59, Egerton Gardens, S.W.

THE ZOÖLOGICAL SOCIETY OF SCOTLAND.—The first annual report of the Zoölogical Society of Scotland gives a brief account of the successful inauguration of the Society and of its Zoölogical Park. We learn that there are four honorary fellows, three hundred and sixty-two life fellows, one thousand eight hundred and eighty-eight ordinary fellows, and six corresponding members. The report contains details as to the animals presented to the Society, and is illustrated by some excellent photographs.

ORNITHOLOGICAL BOOKS.—The sixty-sixth catalogue in Messrs. John Wheldon and Company's new series contains details of more than fourteen hundred books and papers, both old and new, dealing with birds. Some of the books date from the sixteenth century, and come under the heading of "General Systems." The works are well classified according to their subjects, and include illustrated monographs and contributions to a knowledge of classification, morphology, birds of various parts of the world, as well as of species which are kept in captivity.

FALMOUTH OBSERVATORY.—The report of the Observatory Committee of the Royal Cornwall Polytechnic Society for the year 1913 shows that modifications have been recently introduced in the work with a view to the Observatory contributing to the data required in the study of the weather by the Meteorological Office. Tables are given showing the declination of the magnetic needle, sea temperatures, air temperatures, details of sunshine, hydrometric conditions of the air, direction and the velocity of the wind, and the amount of rain.

ADDITIONS TO THE ZOÖLOGICAL SOCIETY'S MENAGERIE.—Among the more important additions to the Zoölogical Society's collection made in April were two elephant seals from the Duke of Bedford, two Indian elephants from *The Daily Mirror*, and two tigers from Major Bigg Withers. A collection presented by Mr. W. K. Pomeroy from Colombia contained two white-browed hares and a pileated heron new to the collection. Mr. Wilfred Smithers contributed two other animals from Argentina, not previously seen at Regent's Park, namely a Merrem's Xenodon and a Neuwied's Viper.

POPULAR ASTRONOMY.—Messrs. G. P. Putnam's Sons announce the immediate publication of "The Essence of Astronomy," by Edward W. Price, which is a popular book telling the things everyone should know about the Sun, Moon, and Stars. It answers in untechnical language the everyday questions of everyday people, the material being so arranged that it is available for quick reference, as well as for interesting consecutive reading. There are many illustrations, while the drawings of Mars are those most recently published, having been made by Professor Lowell in January of this year.

LIVINGSTONE COLLEGE.—Dr. C. Wigram has been appointed to succeed Dr. Charles F. Harford as Principal of Livingstone College. Dr. Wigram is the youngest son of the late Prebendary Wigram, formerly Honorary Secretary of the Church Missionary Society. He was educated at Harrow School, Trinity College Cambridge, and St. Thomas's Hospital, and he is a graduate in Medicine and Arts of the University of Cambridge. He was formerly a Medical Missionary at Peshawar, on the north-west frontier of India, under the Church Missionary Society, and has thus had practical experience of missionary life abroad. He has been for five years on the staff of Livingstone College, first as Resident Tutor, and then as Vice-Principal.

CONCRETE AND CONSTRUCTIONAL ENGINEERING.—The question of the proposed changes in the Concrete Institute is again dealt with in the May number of *Concrete and Constructional Engineering* in its editorial columns. Among the illustrated articles will be found a description of the application of reïnforced concrete in the construction of the Usher Hall, Edinburgh. The new offices of the Metropolitan Railway Company are also described and illustrated, as is also a new building for the port of Para. There is also an article, from the pen of Mr. Chas. F. Marsh, M.Inst.C.E., on "Shearing and Diagonal Tension Reïnforcement in Beams." The question of Electrolysis in Concrete is referred to, and the number contains an article on Lighthouse Construction.

XUM

THE ALCHEMICAL SOCIETY.—At a meeting of the Alchemical Society, held at the International Club for Psychical Research, on Friday night, Dr. Elizabeth Severn gave a very interesting address upon "Some Mystical Aspects of Alchemy," in the course of which she said if at any time the secret of transmuting base metals into gold were ever known, it was quite certain that it was not now. Even if discovered at the present day, it was doubtful whether it would be of any benefit to mankind. If everybody knew the secret they would find time for nothing else but turning base metal into gold. The mystic aspect of the question was, she thought, the practical one, although it sounded something like a paradox.

THE ROYAL INSTITUTION.—On Tuesday, June 2nd, at three o'clock, Professor A. Fowler will begin a course of two lectures at the Royal Institution on "Celestial Spectroscopy"; on Thursday, June 4th, Professor Silvanus P. Thompson delivers the first of two lectures on "Faraday and the Foundations of Electrical Engineering"; and on Saturday, June 6th, Mr. Sigismund Goetze will commence a course of two lectures on "Studies on Expression in Art." The Friday evening discourse on June 5th will be delivered by Professor William H. Bragg, on "X-rays and Crystalline Structure," and on June 12th, by Dr. Walter Hines Page (the American Ambassador), on "Some Aspects of the American Democracy." The Institution has recently issued a statement as to the advantages which it offers to its members, and an illustrated pamphlet dealing with its nature and objects. These can be obtained, by anyone interested, from the Secretary at Albemarle Street.

MICROSCOPES and ACCESSORIES.—We have received from Messrs. Angus & Co., who are the depôt agents for Mr. C. Reichert, of Vienna, an abridged catalogue of microscopes and accessory apparatus made by that celebrated Continental firm. A prefatory note calls attention to the fact that since the founding of the firm in 1876 fifty-five thousand microscopes have been produced and sold by it. We have had some experience of objectives made by Mr. Reichert, and we commend them to the attention of our readers. There is a number of useful accessories, such as a breath screen (for keeping moisture from the stand) and an attachable mechanical stage, which call for attention. The comparison eyepiece for bringing two specimens under different microscopes into juxtaposition in the same field of view should prove of considerable usefulness. Special attention is also given in the catalogue to haematological apparatus and to the latest types of microtomes.

THE INSTITUTE OF METALS, MAY LECTURE.—The annual May Lecture of the Institute of Metals was delivered by Professor E. Heyn, of Berlin, on Tuesday, May 12th.

Professor Heyn said that few persons were conscious of the enormous amount of thought bestowed on the question of soundness of materials by thousands of men fighting continuous struggles against the numerous hidden dangers involved in the intricacy of structural material, and working strenuously towards its perfection and reliability.

Certain structural members might fail even without being subjected to stresses in service. For instance, it had often been observed that condenser tubes made out of brass cracked when simply stored up in the yard. Some articles made out of this metal, when exposed to atmospheric influences, underwent an alteration to such an extent that they might be crumbled between the fingers. Similar phenomena could be stated in structural members made out of other metals and alloys when they were manufactured under unfavourable conditions, which lead to serious internal strains.

The lecturer said that he had made a special study of the phenomena connected with internal strains, and then discussed the means for removing or diminishing them.

METEOROLOGICAL CONFERENCE.—Upon the invitation of the Scottish Meteorological Society, it is proposed to hold a Conference of Observers and Students of Meteorology and Allied Subjects in Edinburgh from Tuesday, the 8th, to September 13th, 1914. According to the provisional programme, the proceedings will open with a Presidential Address at 10 a.m. on Tuesday, September 8th. The mornings will be devoted to the discussion of scientific subjects connected with the study of the atmosphere. The afternoons will be available for demonstrations; lectures are to be arranged for two evenings, and perhaps a reception for another. On the Saturday there will be excursions to places of scientific interest. The scope of the papers to be discussed will, it is hoped, include the physical and observational aspects of Meteorology, Climatology, Oceanography, Limnology, Atmospheric Electricity, Terrestrial Magnetism, and Seismology. One of the objects of the Conference will be to bring together observers in these departments of science and those who are interested, from the theoretical point of view, in the discussion of the observations. Special attention will be given to the teaching of Meteorology in schools, and to the relation of Meteorology to Aviation. An exhibition of historical and modern instruments is to be organised. To meet the necessary expenses the subscription for members of the Conference has been fixed at ten shillings. Tickets of admission for ladies accompanying members are to be issued at five shillings. Matriculated students of any university will be admitted as associate members on payment of five shillings. All communications should be addressed to the Honorary Secretary, Edinburgh Conference, Meteorological Office, South Kensington, S.W.

A GIGANTIC LENS.—Messrs. J. H. Dallmeyer have successfully accomplished the task of making a lens of similar character to that of their patent portrait lens, but eleven inches in diameter, with an aperture of $f/4{\cdot}2$. The completed lens is twenty and a half inches long; its width is twelve and a half inches, with a flange diameter of sixteen inches; while it weighs just over one hundred and twelve pounds. It has been made for the use of a photographer in Egypt, who wishes to secure life-sized pictures in natural perspective. The theoretical design presented considerable difficulties, as the standard of definition in the final picture requires to be of as high an order as in the case of a small lens. Aberrations, which increase as the focal length increases, have therefore to be remarkably well corrected, no easy task with a lens of this size. As the diameter far exceeds the separation of the eyes, it was thought that it might be of interest to see what stereoscopic effect could be obtained. A test object was prepared as follows: A thin plate was painted on each side with alternate bands of black and white, arranged so that a black band on the right-hand side corresponded with a white band on the left-hand side. The object was put up about twenty feet from the lens and photographed in four ways: (1) With the lens covered up, except for a small hole in the middle; (2) with the lens covered up, except for a small hole on the right-hand side; (3) with the lens covered up, except for a small hole on the left-hand side; (4) with the complete lens uncovered. The first result corresponds with a photograph taken with a lens of the same focal length, but small aperture, and Numbers 2 and 3 to photographs taken by shifting such a lens five inches to the right and left respectively. The last is similar to what one might expect to see in a stereoscope using both these photographs. In Number 1 there is the end-on view of the plate only; in Number 2 there is the end-on view and also the right-hand side; in Number 3 there is the end-on view and also the left-hand side; in Number 4 there is the end-on view and both sides, the whole thing being combined to form one view. The photographs thus show the ability of a large lens to see round corners. Photographers have often stated that a large lens gives more roundness and modelling in portraiture, and this perhaps is explained by the property of seeing round corners.